THE WELDING ENGINEER

MAY, 1947

IN THIS ISSUE: Spot Welding Structural Steel . . . page 53

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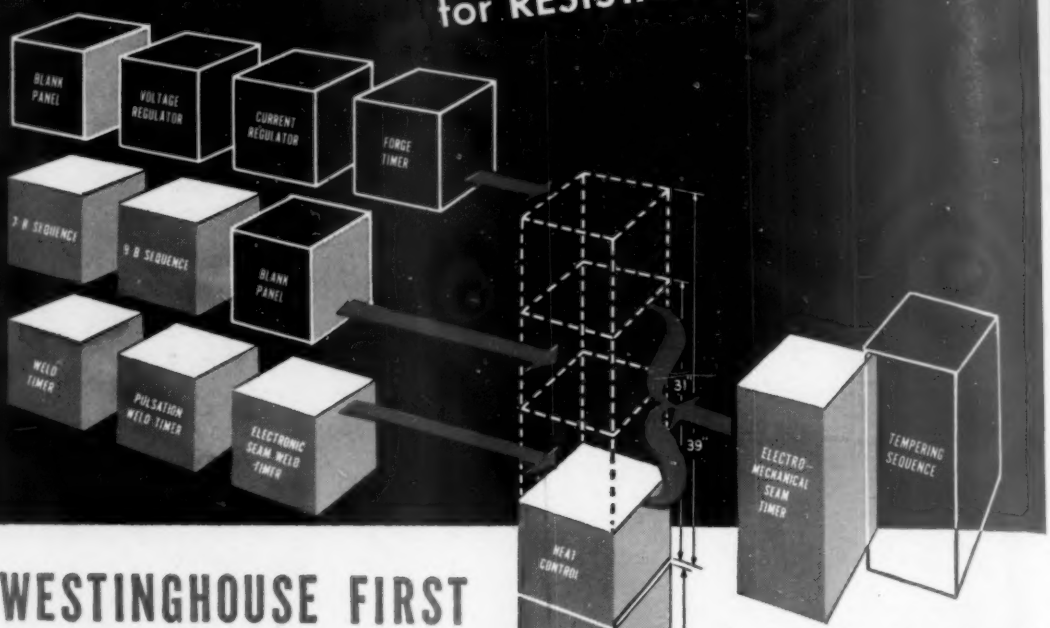
SYNCHRO-TROL ... packaged controls for RESISTANCE WELDING



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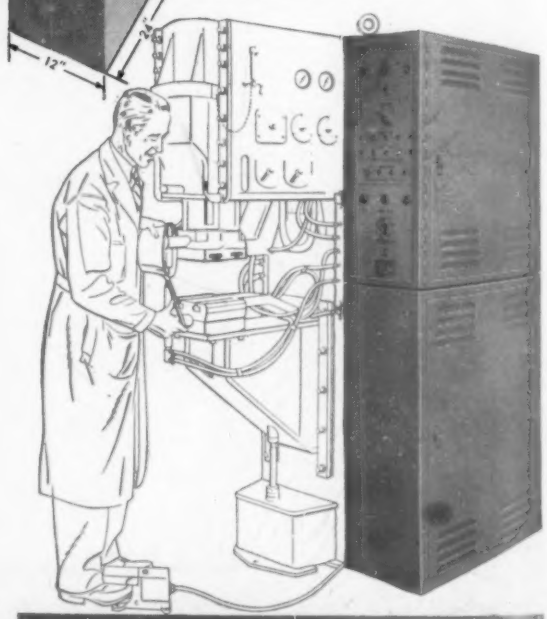

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THE WELDING ENGINEER

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Volume 32 · Number 5 *May, 1947*

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PUBLICATION OFFICE, 212 E. York St., York, Pa. EDITORIAL OFFICE, 520 No. Michigan Ave., Chicago 11. EXECUTIVE OFFICES, 330 West 42nd St., New York 18, N. Y.

Return postage guaranteed. Branch offices, Chicago, San Francisco, Washington, Philadelphia, Cleveland, Detroit, Pittsburgh, St. Louis, Boston, Atlanta, Los Angeles. Published monthly.

McGraw-Hill Publishing Company, Inc. Entered as second-class matter March 12, 1947, at Post Office, York, Pa., under the act of March 3, 1879.

Subscription rates—Single copy 35¢ United States and Possessions $3.00 per year, $4.00 for two years, $5.00 for three years. Canada $4.00 per year, $8.00 for three years. Pan American countries $6.00 per year, $12.00 for three years. All other countries $15.00 per year, two years $25.00 $30.00 for three years.

IN THIS ISSUE

ARTICLES

COVER: *Huge flame-cutting machines are part of the know-how that speeds the production of streamlined passenger cars in the Chicago plant of Pullman-Standard Car Mfg. Co. Guided from a wooden template (left of picture), the torches cut out various designs through several layers of stacked steel plates.*

Production

Stainless-Steel Refrigerator Car 33
TED PALMER

Torch Brazing Aluminum-I 57
HARRY A. HUFF

Maintenance

"Two-Tone" Process Explained 36
W. C. McLOTT

Research

Quicker Calculations for Portable Spot Welders 41
MYRON ZUCKER

Construction

All-Welded Guard Rails 46

Spot Welding Structural Steel 53

Welding British Submarines 62
E. DACRE LACY

DEPARTMENTS

Editorial 31
On the Job 68
Short Cuts and Kinks 70
News of the Industry 72
Engineering Data Sheet No. 80 85
Free Literature 87
New Products to Use 90
About People 98
From the Patent Office 101
Opportunities for Welding 106
Searchlight Section 115
Advertisers in This Issue 116

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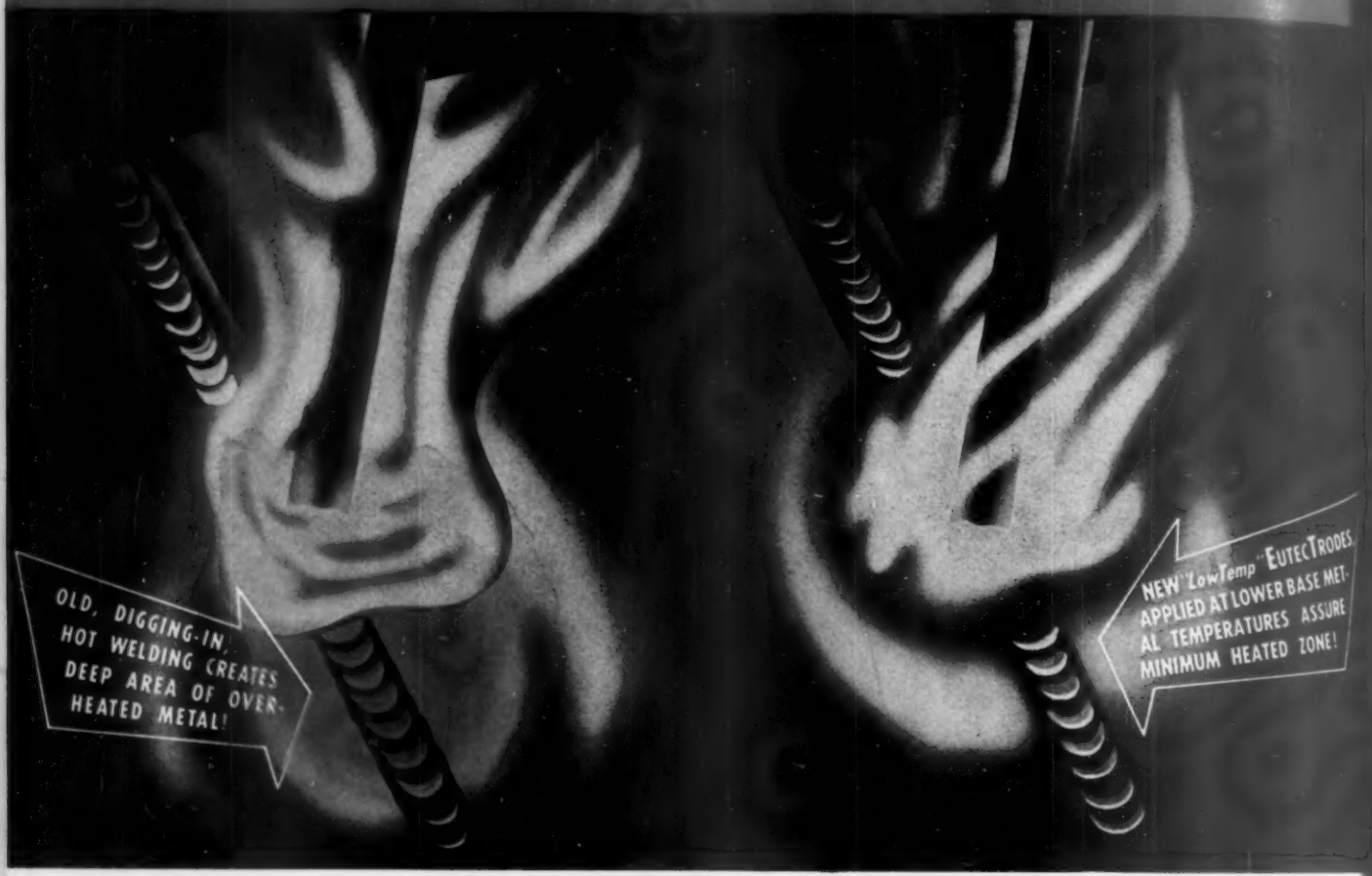
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THE WELDING ENGINEER

MAY, 1947

Too Many Cooks

SINCE WELDING first came into use as a metal-joining process, its users have been bedeviled by those who would regulate its use. When a pressure vessel is to be welded, for instance, certain code requirements must be met. All well and good, but the requirements established by one regulatory body for pressure vessels are not suitable for piping. Piping must be welded in accordance with the code of another organization. And so it goes.

The reason for the seemingly endless confusion is amazingly simple. Whenever welding came to be applied on a particular product, the technical society concerned in the end use of the fabricated product would undertake to set standards for the use of welding in the fabrication. That society, though, might not know nor care about similar work done elsewhere. The result is a Tower of Babel method of code writing. Everyone is writing welding codes—in some instances with the technical assistance of the American Welding Society, in other cases unaided.

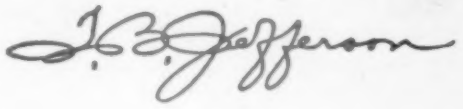
Remember the old saw about what too many cooks do to the broth? They don't improve its flavor. Already some twenty organizations have prepared codes and standards for welding. In some instances two or more codes have been independently developed to apply to a specific product. And if you think that independent thinking on the same problem leads to agreement—well, think again!

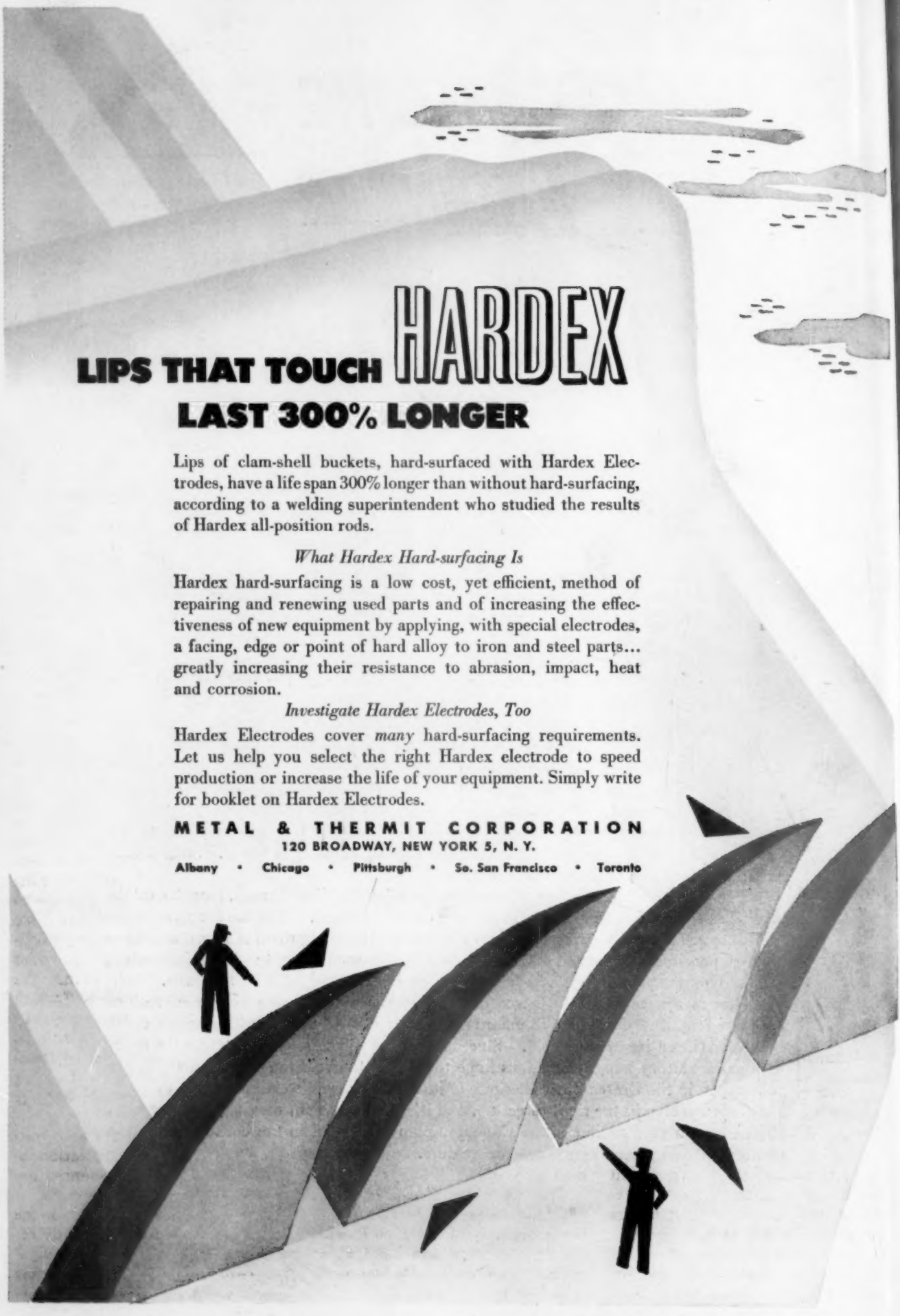
And so confusion becomes worse confounded. Before the tangle gets beyond the power of the human intellect to unravel, the welding industry of the U. S. might take a tip from our neighbors on the North.

The Canadian plan centers around the Canadian Welding Bureau, recently established as a division of the Canadian Standards Association. It is the function of the CWB to insure good welding by approving or withholding approval of shops, engineers and supervisory personnel. Approval will be granted only to those fabricators whose equipment, weldors, supervisors and engineers satisfy CWB standards.

Bureau approval will be based on qualification under codes and specifications prepared by the Canadian Standards Association. The CSA will prepare codes covering the entire welding field. Since all welding will thus be done under the codes of one regulatory body, Canadians hope to be able to avoid the confusion which has developed in the United States because of its multiplicity of welding codes.

This is a step in the right direction, and it's time we began moving the same way. The sooner a plan similar to the Canadian plan is adopted in the United States, the better for everyone concerned with welding.





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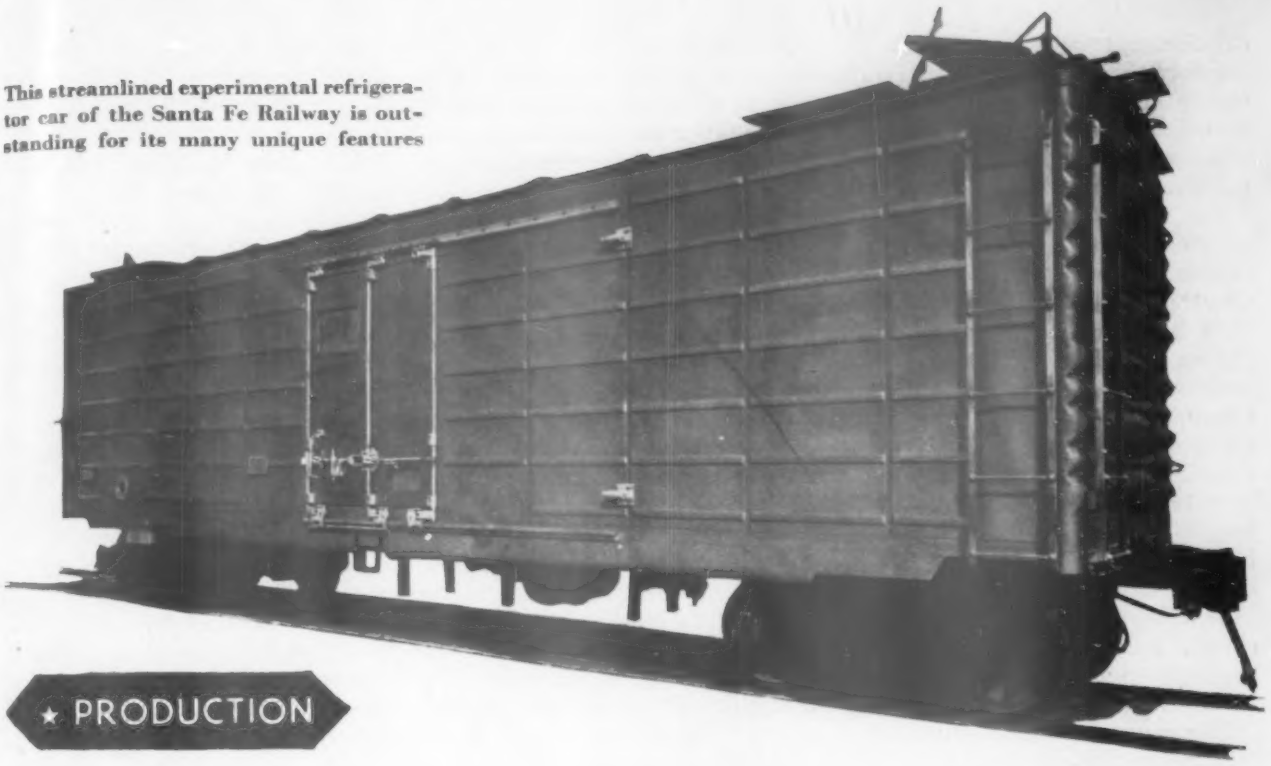


This streamlined experimental refrigerator car of the Santa Fe Railway is outstanding for its many unique features

★ PRODUCTION

Stainless-Steel Refrigerator Car

BY TED PALMER

Modern welding techniques in the construction of the underframe and superstructure give maximum strength with minimum weight. An innovation for the ordinarily drab refrigerator car is the stainless sheathing, joined to the side frame by submerged-melt automatic welding.

THE Santa Fe Railway was confronted by the problem of developing a freight car which would provide improved refrigeration for fruit and vegetable shippers and would also serve as a general-purpose 40-ft., 40-ton car. This car had to meet the mechanical requirements of the Association of American Railroads and of the Interstate Commerce Commission. In addition, its design must permit the inclusion of all of the features which the Santa Fe regards as important to maintain.

The answer was found in Santa Fe car No. 13000, built for the railway by the Consolidated Steel Corp., Los Angeles. Believed to be the first stainless-steel refrigerator car ever constructed, it is neither a radical nor revolutionary design but a composite of the railway's fifty years of experience with refrigerator cars and a similar period of experience by Consolidated Steel Corp. in the fabrication of metal products which have ranged from steel buildings to ships to railroad cars.

The new car measures 40 ft 5⅜ in. between inside linings and has a capacity of 1,973 cu ft with the bulkheads in and 2,316 cu ft without bulkheads. Its load limit is 78,800 lb.

Water ice was selected for this general-purpose car after a careful study of existing alternatives. Mechanical refrigeration is still in the experimental stage for railway freight cars, and such units constitute added weight when hauling empty or when the car is in use as a non-refrigerated freight car. Ice is economical and is readily available when needed. It provides the moist atmosphere within the temperature range of 35–40 F which is required by the great majority of loads. Furthermore, it acts as its own thermostat and (without salt) cannot achieve a freezing temperature which would damage the lading.

Air circulation was the next consideration. Natural circulation requires temperature differences between the top and bottom or between the ends and center of the car. Tests show that the differences may be as much as 20 F before natural circulation becomes effective. A forced-reverse air cir-

culation maintains a uniform temperature. Such a method of air circulation is also highly desirable for ladings like oranges and cherries which generate heat, and for loads not thoroughly precooled.

For frozen cargo, the primary purpose of the refrigeration is to absorb whatever heat manages to penetrate the heavy insulation. This is best done by circulating the cool air along the inside of the insulated surfaces instead of through the load. A means of directing the flow seemed very desirable. A lever over each door operates louvers extending the length of the car between bulkheads to open or close air ducts on the inside walls and doors. When the 1-in.-thick ducts are closed, they form an additional dead-air-space insulation along the car sides and doors.

The convertible ice bunkers are built of galvanized steel to resist the corrosion of water and salt. The floor racks are also galvanized steel. The bunkers take advantage of new techniques of the aircraft industry for maximum weight saving and also take full advantage of forced air circulation; they expose maximum ice surface to the circulating air and have far fewer parts than conventional bunkers.

The fan system selected permits direct contact of air and ice, eliminating need for the conventional ice basket. Ordinarily, the fans are driven from the car wheels, but when the car is stationary, electric motors can provide air circulation equivalent to the circulation at fifty miles per hour for precooling purposes.

Car Construction

With the above features settled, the car was designed to take full advantage of its refrigeration and to provide the maximum circulation of cool air for both frozen and non-frozen loads and precooling needs.

Welded construction was used for the underframe to achieve maximum strength with minimum weight. The center sill is made of railroad Grade A steel (tensile strength 60,000 to 72,000 psi) because of its higher physical properties compared with the lower grades customarily used. Yoloy,* a weldable low-alloy steel (2% nickel and 1% copper) of high yield point was used for the bolsters. The center sill was reinforced at the ends by welding plate and bar material to it; this eliminated the usual heavy striker castings.

In the side frames, a structural-type welded truss with tension diagonals takes most of the stress off the side sheathing. A "hat section" for diagonals gives rigidity. Both posts and diagonals were made of the same Yoloy as the bolsters in order to secure maximum strength per pound and increased corrosion resistance.

For the sheathing of the side panels, 18-gauge cold-rolled 18-8 stainless-steel sheet was selected. This is a material well known in passenger cars, food processing installations and building construction. It costs more than some other materials, but it was hoped the differential would be reduced before the car had been in service over a long period.

Cold-rolled 18-8 stainless is readily weldable and permits making of a complete seal. It is hard and strong and will resist denting. It is very resistant to corrosion. It retains its luster and physical properties and requires no painting. Its heat conduction is half that of mild steel of the same thickness.

In the flat condition, stainless sheets are difficult to weld without distortion. Furthermore, they are affected by changes in temperature. To overcome this disadvantage and obtain additional rigidity, horizontal ribs were pressed in the sheets (see Figs. 1 and 2). This permitted relatively thin sheets to

---

*See "Weldable Alloy Materials," page 76, The Welding Engineer, November, 1946.

Fig. 1—A submerged-melt welding head was used with stainless-steel wire to join sheathing to side frames

be welded to the side frames on all four edges without distortion. The welding was done by the submerged-melt automatic process (Fig. 1) at a rate of about 60 in. per minute, using stainless welding wire.

The car ends were fabricated of stainless-clad steel by the Standard Railway Equipment Co. The roof, manufactured by the same concern, was of hot-dip-galvanized steel. It was not added until side and end construction had been completed (Fig. 2).

Insulation and Doors

Fiberglas and Silvercote paper insulation panels are used in the sides, ends and roof. The Fiberglas is 5 in. thick at the sides of the ice bunkers and 3½ in. elsewhere. There is an additional ½-in. insulation in the roof. The floor has 4 in. of Hairinsul plus standard Mulehide asphalt construction with 1¾-in. wooden floor between and $^{25}/_{32}$-in. tongue and groove beneath. The walls and ceiling are covered with plywood, and the edges are sealed against moisture. There are two layers of plywood on the sides. These have either a 1-in. air duct or a dead air space between them, depending on the position of the louvers.

The doors are unique and merit special consideration.

Most refrigerator car door openings are only four to five feet, and swinging doors are standard. In planning the new car, it was desired to have the same six-foot opening as a standard box car. Swinging doors have many inherent disadvantages, and for a six-foot door they become highly undesirable. It is, for example, very difficult to open or close a large swinging door because of the friction of the packing.

The new-type door, on which patent applications are pending, is a sliding door of two panels hinged at the center. When closed, no part of the fixtures or track extends out as far as the fixtures on swinging doors. When open, no part extends out from the side of the car as far as swinging doors for smaller openings.

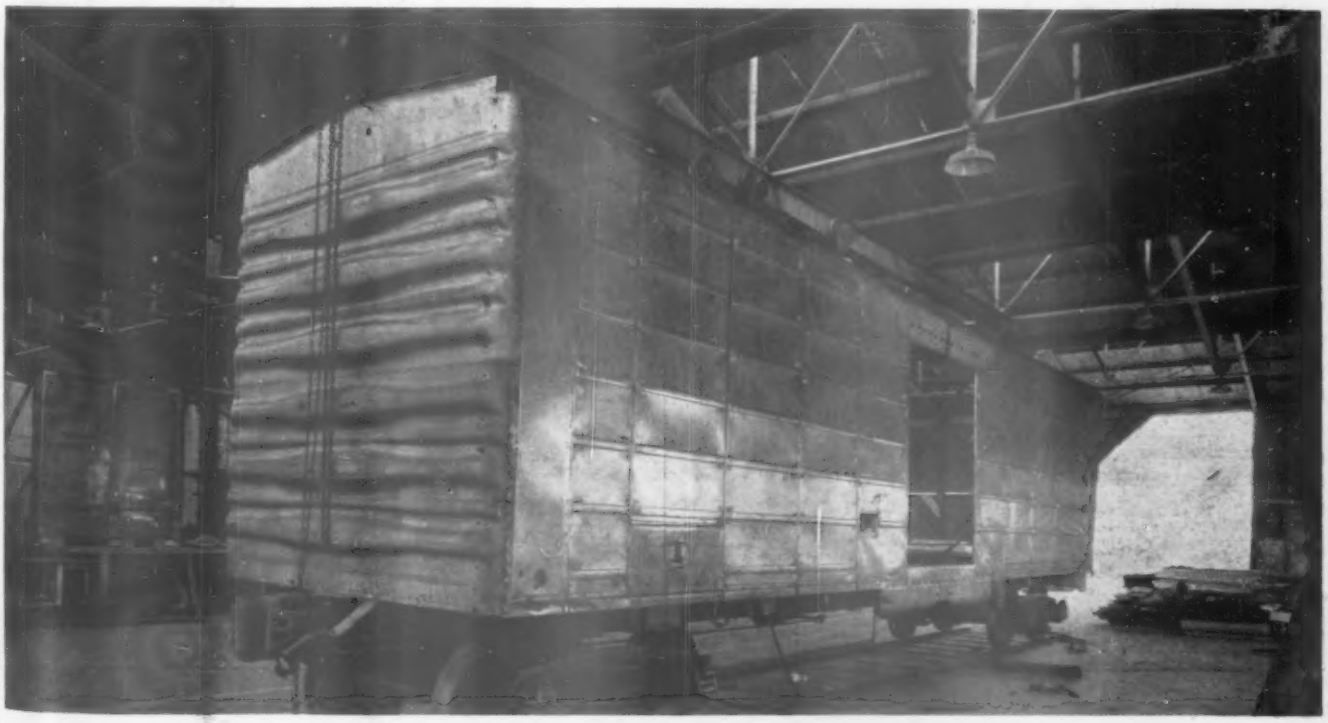
The first requirement for a refrigerator car door is a tight seal. The new door uses the toggle principle, permitting great pressure at the side jambs with little manual effort. Beveled strips at the vertical edges lock against the door jambs to resist lateral pressure without interference with the normal opening and closing.

The new door works excellently in the six-foot opening of this experimental refrigerator car. Opening and closing is simple and require less manual effort than do smaller swinging doors.

The door mechanism has relatively few parts and is very rugged. The bottom track is a standard box car track and carries the main load. The upper track is a formed Z-section. The doors are fastened to three vertical rods, to one of which is fastened the operating bar. The rods are connected to the tracks by swing hangers at the bottom and top. The ball-bearing rollers are triple sealed against moisture and grit.

To summarize, this new stainless-steel car offers many advantages over standard refrigerator car construction. The circulating moist-air refrigeration system has been materially improved for a general-purpose car. Modern welding methods and use of the best developments in metals permit weight saving without sacrifice of strength. The car design is adaptable to the use of considerable aluminum and other lighter construction for a particular railroad's requirements in cases where light weight is a major consideration. The stainless-steel ribbed siding should prove as practical as it is pleasing in appearance. Finally, the new-type door should prove to be a very practical contribution to all types of refrigerator car construction.

Fig. 2—Ends and side panel assemblies erected. The pressed ribs provide rigidity and a distinctive appearance



"*TWO-TONE*" Process

The Two-Tone arc process may be used to weld, rebuild or hard-face heavy sections of machine parts of a wide variety of purposes. Contractors, dredgers, quarriers, mines and railroads should find it effects substantial savings in the "down time" of large equipments.

★ MAINTENANCE

WITHIN recent years there has been developed a method of welding that uses filler rods in conjunction with an electric arc instead of with the oxy-acetylene torch. The higher, more concentrated heat of the electric arc melts down and deposits proportionately greater amounts of metal in a given time on worn surfaces. This process, therefore, is well suited to the repairing and rebuilding of comparatively heavy sections of machine parts.

How It Works

In the "Two-Tone" process, a secondary dead electrode or filler rod is held in proximity to the arc of a common metal-arc electrode. Any analysis of filler rod can be used, depending upon the material desired to be deposited upon the parent metal. If the desire is to rebuild a large bronze bearing or a bronze ship's propeller, for instance, a bronze electrode of the desired analysis can be used with a larger filler rod of the same analysis, enabling the deposit of greater amounts of metal in a shorter time than could be done with an oxy-acetylene torch. Should it be the desire to rebuild a mild-steel part where quite heavy deposits were desired or permissible, there could be used a mild-steel electrode with a larger size of mild-steel filler rod. The size of the electrode and the filler rod would, of course, be dictated by the quantity of metal that is to be deposited or the thickness of the section of parent metal.

Contrary to first thought, the Two-Tone process does not heat the parent metal to as great an extent as the oxy-acetylene method of application. Though higher temperatures are involved, a greater amount of metal is melted from the electrodes and the duration of the heating of any given spot is very short compared to the heating required by the oxy-acetylene torch. Then, too, the temperature of the molten puddle can be readily controlled by the length of the arc or the amount of filler rod added to the molten puddle. There is still a further advantage, that of being able to work close to an edge and still have enough heat available to obtain a satisfactory bonding.

The position of the filler rod in relation to the live metal-arc electrode is shown in Fig. 1. The live electrode must be tilted 30 to 45 degrees from vertical in order that the filler rod can be presented to the edge of the arc. As the arc must be maintained between the live

Fig. 2—Before rebuilding. This bucket for a gold dredge weighs several tons and is cast from manganese steel. Note the badly worn condition of the bottom

Fig. 3—After rebuilding. The same bucket shown in Fig. 2 after rebuilding the bottom with nickel-manganese filler rods and E-6010 electrodes. Note the wide beads

Explained

BY W. C. McLOTT
President, The Resisto-Loy Co.

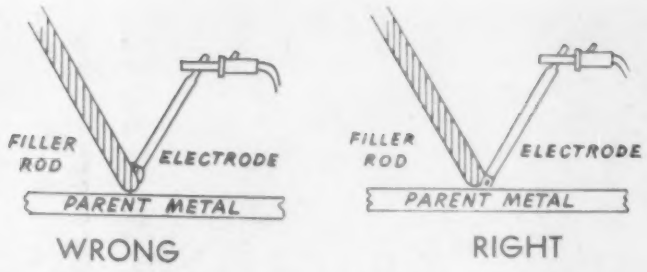


Fig. 1—Right and wrong ways of holding the filler rod. Note that the arc must come between electrode and parent metal, not between the electrode and filler rod. Both rods should be moved in unison to lay a wide bead

electrode and the parent metal, not between the live electrode and the filler rod, the latter should never be thrust between the live electrode and the parent metal. The right and wrong ways of holding the filler rod appear in the sketch (Fig. 1).

The filler rod must be held in close proximity to the tilted live electrode at all times and kept in unison with it when the live electrode is moved from side to side to weave a wide, flat bead. The width of the bead is governed by the size of the live electrode and the surface of the parent metal to be covered. Upon large, heavy sections, it is possible to lay beads 2 in wide and ⅜ of an in. thick at a single pass, using a ¼-in. live electrode and a ⅜-in. filler rod.

Recommended Electrodes

It is also of great importance to use the proper type of live electrode. Thousands of experiments have proved that the preferred types are a heavy coated hot rod like the E-6010 electrode where a d-c motor-generator arc welder is used or the E-6020 or E-6030 where an a-c transformer is used. The E-6012 or E-6013 electrodes are not recommended because the flux is more troublesome and penetration is poorer. Another advantage of the E-6010 electrode is that the operator can produce a thicker deposit because the deposited metal freezes quicker. This quicker freezing also enables an operator to control his deposited metal when he is welding near an edge or upon a curved surface.

In the Two-Tone process, the live electrode is loaded with from 30 to 50% more amperage than normal. This excess heat or amperage, however, is used to melt down the filler rod so that we actually have less heat to disturb the parent metal than in the single-electrode method of deposition. Because of the quantities of live electrode and filler rod melted down, the Two-Tone process is three or four times faster than the single-electrode method. Less heat is absorbed by the parent metal, however, and so welding actually takes place at lower temperatures. The lower temperature is a distinct advantage when repairing and rebuilding manganese steel castings and other similar materials. Great difficulty in the past has been experienced by weldors in repairing and rebuilding these steels because of heat-zone fracture occurring after or during the cooling of the deposited metal. This peculiar heat-zone fracturing also occurs in rail end welding and in materials subjected to severe impact.

Weld quality will be improved if the E-7010 electrode is substituted for the E-6010 in d-c welding and the E-7020 or 7030 electrode for the E-6020 or 6030 electrode in a-c welding. The principal difference between the E-6000 series and the E-7000 series is that the latter contains ½% molybdenum. The small amount of this powerful alloying agent definitely improves the physical characteristics of the deposited metal.

In the original experimentation, many alloy filler rods were developed to give various desirable characteristics to the deposited metal. So many alloys for so many different purposes seemed to confound users and potential users of the process. We found that three alloys would meet most of the requirements for such applications as earth-and-rock-moving equipment, mining and dredging machinery, cement mill and quarry equipment, etc.

Fig. 4—Heavy dragline bucket being restored to serviceability. The rebuilding of this bucket called for 130 lb of ⅜-in. nickel-manganese rods and 134 lb of E-6030 electrodes. The job was done in twelve hours and saved ⅔ the cost of a new bucket

Nickel-Manganese Alloy

The first alloy is a cast composition of 10% nickel, 30% manganese, 2% carbon and appreciable amounts of vanadium, boron and molybdenum in iron. This alloy, when used 50/50 with an E-6010, 6020 or 6030 electrode, will deposit metal of characteristics comparable to the best grades of nickel-manganese single electrodes

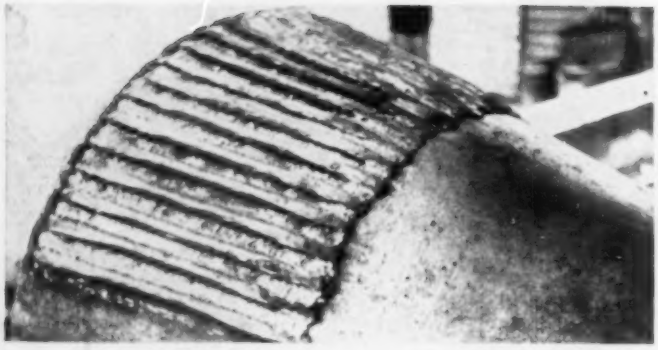


Fig. 6—The crusher mantle above shows how applicator bars may be used in the rebuilding of a worn surface

Fig. 5—The large crusher jaw pictured on the right was built up to a depth of 9 in. by using the Two-Tone process in conjunction with a meshwork of applicator bars

after impacting (or peening). A 50/50 deposit, moreover, only requires about a tenth of the peening that is necessary on a weld deposit from a single nickel-manganese electrode. It is only necessary to peen the Two-Tone deposit sufficiently to stretch the cooling metal to make up for the natural shrinkage occurring on cooling. The vanadium content prevents checking and heat-zone fracture; the boron controls the initial hardness and holds it at around 480 Brinell, while the molybdenum content controls grain growth and porosity in both the deposited metal and the parent metal and prevents the heretofore mentioned heat-zone fractures. This nickel-manganese type of filler rod can be used with satisfaction and safety in repairing all types of manganese-steel castings or nickel-manganese steel forgings such as dredge buckets (Figs. 2 and 3) dragline buckets (Fig. 4), jaw crusher plates (Fig. 5), crusher mantles (Fig. 6), shovel teeth, pump impellers and housings . . . in short, any manganese or nickel-manganese steel.

The large crusher jaw shown in Fig. 5 was built up to a depth of 9 in. over a width of 26 in. and a length of 72 in. The total metal added exceeded two tons, including ¾ ton of nickel-manganese filler rods, ¾ ton of E-6010 electrodes, ½ ton of nickel-manganese applicator bars and 300 lb of a special wear-resisting alloy. The applicator bars were cut 24 in. long and tack welded on 3-in. centers. The space between them was filled with nickel-manganese filler rods applied by the Two-Tone process with E-6010 electrodes. Another layer of 72-in. nickel-manganese bars was applied lengthwise, spaced on 3-in. centers, and the intervening spaces were again filled by the Two-Tone process. This procedure was repeated until the full 9-in. depth of wear had been completely filled in with a reinforced mesh of nickel-manganese steel and weld metal. Two final criss-cross passes of 5/16-in. wear-resisting alloy electrodes completed the job. The total savings exceeded $3,800 over the cost of new equipment, and the rebuilt crusher jaw was still performing after three years of service, crushing better than 2,000 tons of rock per day.

Another illustration of the use of applicator bars is shown by Fig. 6. This manganese crusher cone, 3 ft and 2 ft in diameters by 5 ft high, was rebuilt by much the same method used for the crusher jaw. First, swaged nickel-manganese applicator bars were tacked in place and welded down with coated nickel-manganese electrodes, and then the spaces between the bars were completely filled by the Two-Tone process, using nickel-manganese filler rods with E-6010 electrodes. A final single pass of ¼-in. self-hardening, high-tensile electrode was applied for additional wear resistance. As thus rebuilt, the productive life of the cone trebled, and its output increased several times over that of the original crusher mantle.

Fig. 7—This cement mill roll head exemplifies flat impact and severe abrasion. The weld deposit must be wear-resistant and have strength great enough to prevent spalling

"Tough and Hard"

The second alloy is a complex alloy cast rod containing medium amounts of chromium, molybdenum, boron and titanium in iron with about 2% carbon. This alloy

Fig. 8—Ladder roller for a gold dredge before rebuilding. These rollers have to support the bucket lines, which may weigh as much as several hundred tons

Fig. 9—Ladder roller after rebuilding, using "tough and hard" filler rods. Worn dredge buckets are also salvaged by Two-Tone welding (see Figs. 2 and 3)

is designed to provide a tough and hard wear-resisting surface on any steel part of either of the cast or drawn type. It also is very advantageous for rebuilding cement mill roll head rollers (Fig. 7), which are cast iron in most instances. Three such rolls are centrifugally rotated in the flat position against the inside of a large die ring to grind cement clinker. Thus the hard-facing must be able to resist abrasion, while its tensile strength should be great enough to prevent spalling. Carbon content of the alloy should not exceed 2¼% so that rewelding over the worn surfaces will not cause a brittle zone to occur between the layers of hard-facing. Though the roll shown in Fig. 7 is cast iron, it can be hard-faced successfully if the heat is distributed uniformly about the periphery by a skip-welding procedure.

Deposits of the "tough and hard" alloy will withstand without spalling flat and rolling impact such as is encountered in roll heads, dredge ladders (Figs. 8 and 9) tractor track rails, etc. The comparatively low carbon content of this wear-resistant alloy permits repeated build-ups without subsequent layers flaking off.

For High-Carbon Steels

The third alloy is a drawn rod containing chromium, nickel, molybdenum and boron with 1.25% carbon. This alloy is intended to be used in the Two-Tone process for rebuilding all cast and drawn high-carbon steels such as tractor rails, frogs, guide rails, rolling mill guides, edge rollers in steel plate mills, rail ends, switch points, etc. The deposited metal will have approximately the same analysis as the high-carbon steels used for these purposes, with the addition of the previously noted alloying, which is definitely advantageous.

An example of rebuilding with the "high-carbon" type of alloy is the die ring shown in Fig. 10. This badly worn ring was rebuilt by the Two-Tone process, using filler rods of the "high-carbon" type with E-6010 electrodes. The job was completed by application of a good, non-spalling hard-facing. The working life of the ring was vastly increased.

Building up Layers

The use of an alloy live electrode will oftentimes give definite and decided advantages, particularly where several superimposed layers of deposited metal are required to build up to an original dimension. An outstanding illustration is depicted in Fig. 11, a sketch of a mantle used in a gyratory rock crusher.

Crusher mantles wear severely on the lower third of the outside of the bell. This wear is even all around but varies in depth vertically where it is opposed by the liners. The wear depth also increases toward the sizing edge or at a point slightly above the actual bottom edge of the bell. In rebuilding one of these mantles, the first step is to lay the assembly horizontally upon a pair of edges or suitably placed trunnion rollers so that the upper side of the bell will be reasonably horizontal.

The nickel-manganese filler rod and E-6010 electrode are used to apply the first beads. These are laid in the section of greatest wear indicated by No. 1 in the sketch—two beads each 1½ in. wide and about 4 or 5 in. long. Depth of the deposit is about ⅜-in. at the point of greatest wear and tapers slightly so that the bead surface is approximately level.

After the first deposit, the bell should be rotated 180 degrees and two more similar beads laid. It is then rotated 90 degrees for two more similar beads—then another 180-degree rotation for two more beads, etc. Finally the bell is rotated so that the first two beads are nearly on top. Two more beads are laid, and the bell is rotated until the second pair of previously laid beads are on top, and so on—quartering and halving the rotation until all the beads are joined together.

As each pair of beads is laid, they should be peened with eight or ten heavy blows of a cross-peen hammer before the bell is rotated to the next point of rebuild. After the final pair of beads has been peened, the second layer (No. 2 in Fig. 11) is begun as soon as the bell is cool enough so that the bare hand can be laid within a few inches of the deposited metal. For the second layer of beads, the same nickel-manganese filler is

used, but the live electrode should be changed to an E-7010 type. The same welding procedure should be used as previously described, but the second set of beads should span the joint between any two previously laid beads, i.e., the second beads are staggered over the joints of the first beads. The same depth as before (about 3/8-inch) is deposited, each bead tapering out at the ends beyond the first-laid course. Each pair of beads should be peened as before.

If the bell has not been built to original contour by these two courses of weld metal beads, a third course (No. 3 in sketch) may be laid upon the second course, staggering the beads over the joints as before. If the third course is necessary, it has been found advantageous to change the live electrode to an alloy type. A high-tensile, self-hardening electrode that contains chromium in amounts of about 12 to 15% with increased quantities of molybdenum over the E-7010 series is recommended. This electrode also contains some boron and titanium to control porosity and has a very low carbon content so that hardness is obtained without any embrittlement. The deposited metal is a high-tensile alloy of medium-high hardness, Brinell 520-560, that is capable of imparting extreme impact and high abrasion resistance to an already tough, abrasion-resistant steel.

If the above instructions are followed faithfully, a wear-resistant and impact-resistant surface will be produced that will outperform the original new crusher mantle at least three to one. There are records of several mantles rebuilt as outlined above that have outworn and outcrushed in tonnage of stone an average better than three times the performance of the original mantle. The rebuilding, moreover, costs only about two-thirds the price of a new mantle, labor and material considered.

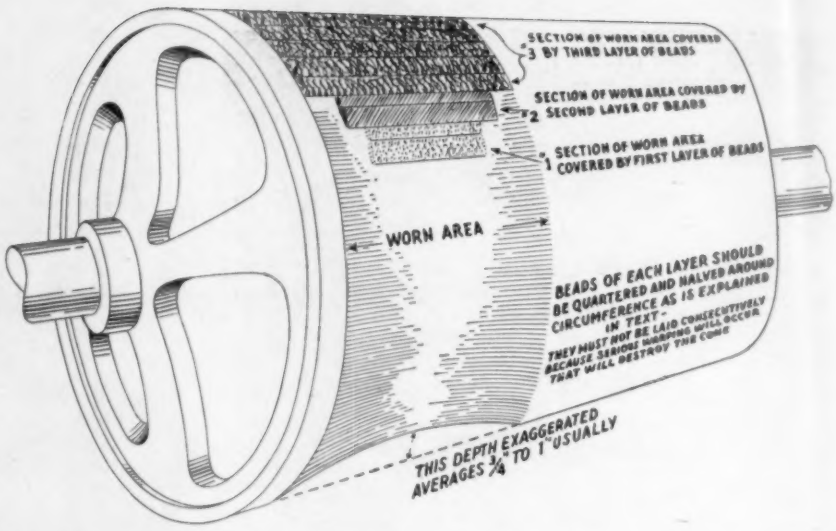

SECTION OF WORN AREA COVERED BY 3 BY THIRD LAYER OF BEADS
SECTION OF WORN AREA COVERED BY 2 SECOND LAYER OF BEADS
SECTION OF WORN AREA 1 COVERED BY FIRST LAYER OF BEADS
WORN AREA
BEADS OF EACH LAYER SHOULD BE QUARTERED AND HALVED AROUND CIRCUMFERENCE AS IS EXPLAINED IN TEXT -
THEY MUST NOT BE LAID CONSECUTIVELY BECAUSE SERIOUS WARPING WILL OCCUR THAT WILL DESTROY THE CORE
THIS DEPTH EXAGGERATED AVERAGES 3/4" TO 1" USUALLY

Fig. 11—Sketch of a gyratory crusher mantle illustrating a method of rebuilding in layers. Section No. 1 shows the first layer of beads covered by nickel-manganese filler rods and E-6010 electrodes. No. 2, the second layer, uses E-7010 electrodes, and No. 3, the final layer, uses a special high-tensile self-hardening type of electrode with the same nickel-manganese filler rods

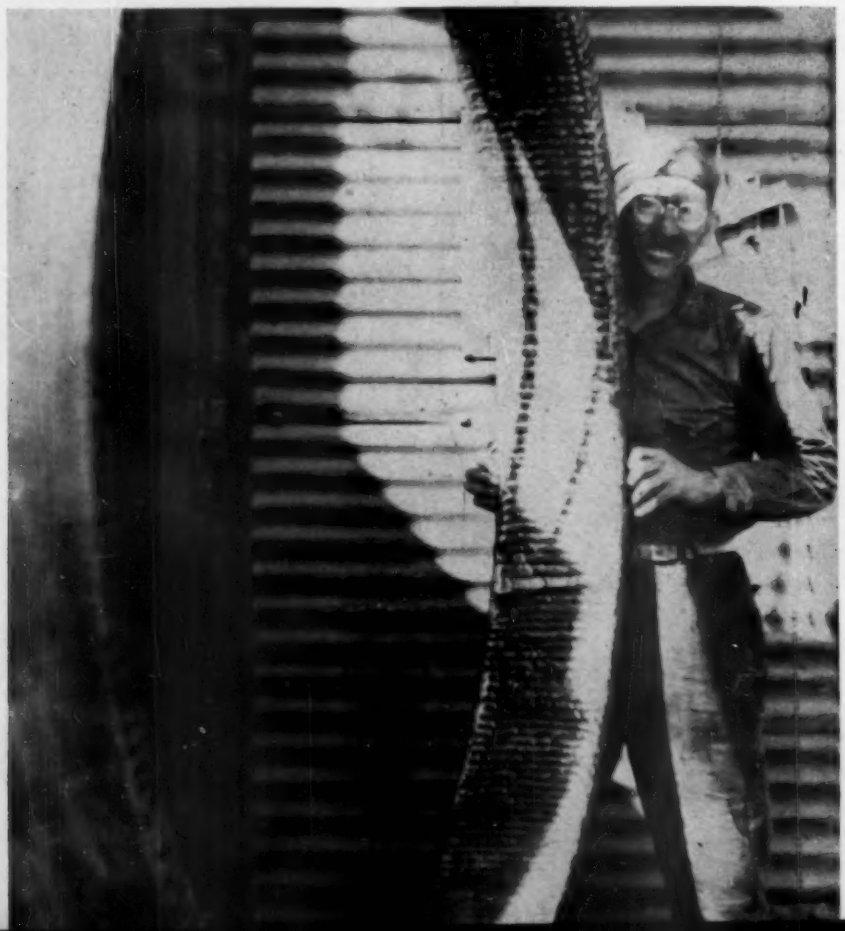


Fig. 10—Badly worn die rings can be rebuilt by using the "high-carbon" type filler rods and E-6010 electrodes

Jaw Crushers and Shovel Buckets

We also have instances of power shovel buckets relined and rebuilt by the Two-Tone process that have returned many times the cost of rebuilding as compared to new buckets and of jaw crushers rebuilt for about one half the cost of new plates that have definitely outperformed new plates three and four to one.

The Two-Tone process is comparatively simple and is easily learned by any weldor who can draw an arc. The costs of deposited metal are surprisingly low because nearly three times the poundage can be deposited in the same elapsed time as by the single-electrode method of deposition.

★ RESEARCH

Quicker Calculations for Portable Spot Welders*

Choice of cable and transformer size for portable spot-welding guns used to be a matter of either advanced calculus or "by guess and by golly," but neither higher math nor guestimating are necessary now. Mr. Zucker's charts take into consideration all of the relevant factors while eliminating most of the figuring.

BY MYRON ZUCKER, *Vice-President, Mackworth G. Rees, Inc., Detroit*

ALONG comes a gun-welder job in which the gun must be continually turned, twisted and pulled into awkward corners. This calls for very flexible cables—which means the smallest possible ones. How small a cable will carry the work without overheating? How much in terms of transformer size must be paid for the flexibility because of the higher secondary voltage required to pass the current through the smaller cable?

This is one example of circumstances where some advance figuring saves money and headaches. It is frequently wiser to do a few simple computations than to go by rule-of-thumb carried over from past jobs, especially when low-reactance cables are being applied in a plant where single-conductor cables have customarily been used.

The charts presented make the selection of water-cooled cables so simple that the "man on the job" is invited to do his own figuring.

Choice of Cable Length

Cable length can be selected without much regard for cable characteristics. While it is true that best electrical efficiency is obtained with the shortest cable, it is also true that best production efficiency is often gained with cables of considerable length. Increased length is advantageous in terms of flexibility—of both the cable and the work area that can be covered. Before low-reactance cable was available, length *had* to be minimized because it was impracticable to build transformers to provide the required welding currents. But now, for instance, 0.125-in. carbon-steel sheet can be welded with a 28-v transformer and low-reactance cable 15 ft long. Hence set-ups are being based more on mechanical convenience than on electrical limitations. A good rule is to take a cable length that produces an economical balance between equipment cost and production rate.

Table I gives a check list of the effects of cable length on portable spot welders and Table II the factors favoring large or small gun-welder cables. Many of these points are so ingrained in the minds of welding men that they are not mentioned ordinarily.

With regard to cable type, the welding engineer takes it for granted that water-cooled cables will be used on gun welders. However, he has the choice between ordinary (paired single-conductor) cable and two types of low-reactance cables: interleaved and concentric.

Ordinary cables are practically

* Abstract of paper presented at the 27th annual meeting, AWS, Atlantic City, Nov. 17–22, 1946.

Table I—Effects of Length of Secondary Cable

	Short Cable	Long Cable
Electrical		
Power demand	Lower	Higher
Line-voltage drop, flicker on lights	Less	Worse
Electric power cost	Lower	Higher
Cost		
Number of welders for given coverage	More	Fewer
Cost per foot	Higher	Lower
Total cost of welder and maintenance	Depends on job; more small welders with short cables may cost more or less than fewer units with longer cables	
Mechanical		
Cable flexibility	Less	Greater
Cable weight	Less	Greater
Production rate	Depends on job	Depends on job

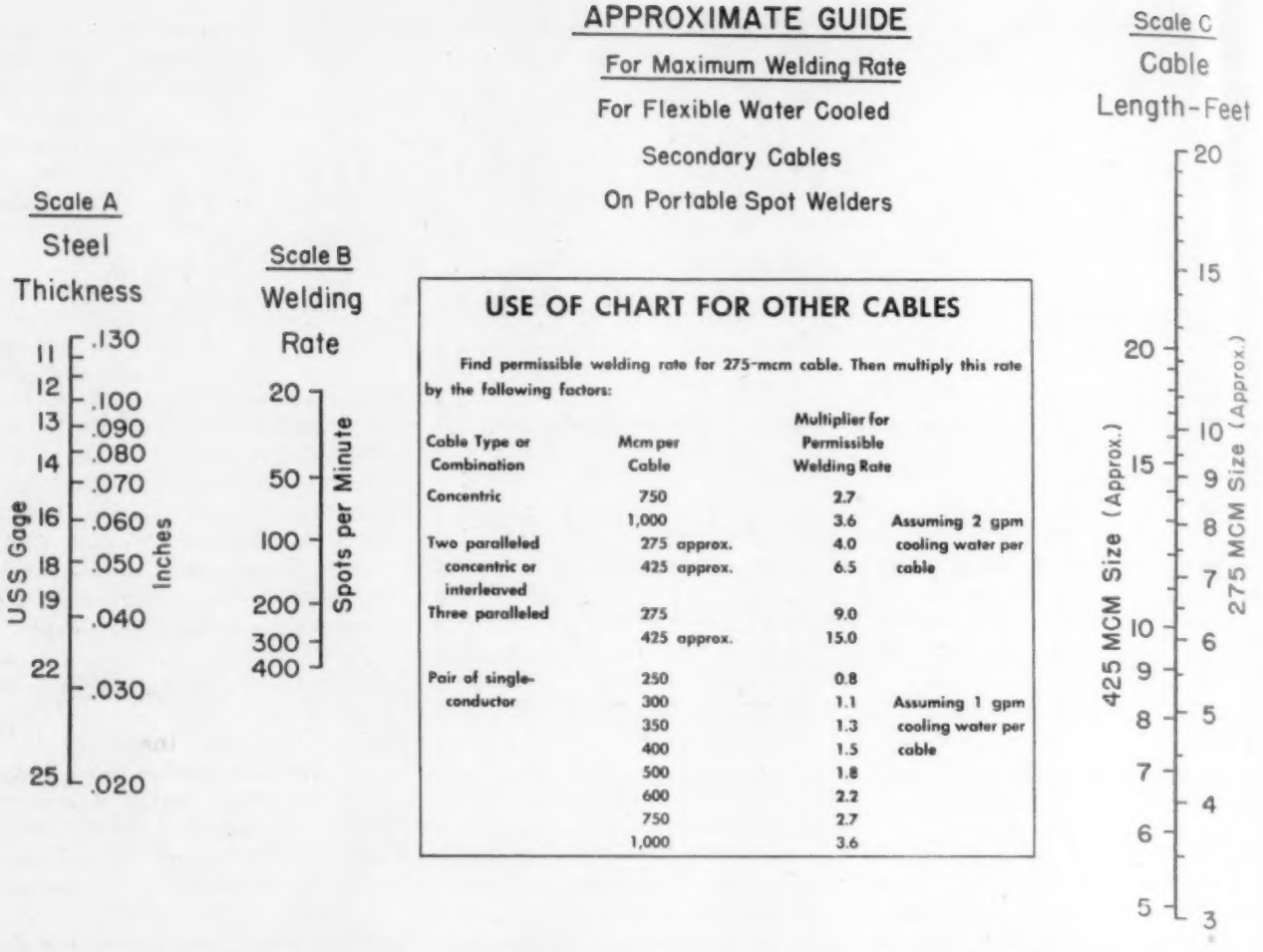


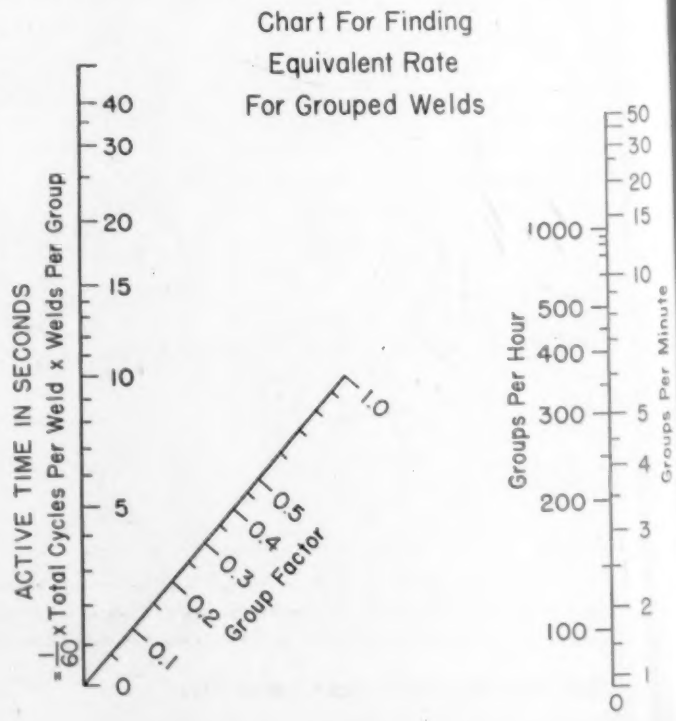
Fig. 1—Approximate guide to determine maximum welding rate for cool operation of two sizes (275 and 425 mcm shown on scale C are averages of sizes commercially available) of flexible water-cooled secondary cables on spot welders. This chart is based on: (a) one gallon per minute 60 F cooling water per electrical side at pressure of 20 or 50 psi, depending on whether water paths are in parallel or in series, and (b) welding energy that is reasonably close to the AWS standards for well separated spots in clean low-carbon steel

required on push guns (unless series welding can be used) and on certain older guns with terminals not designed to adapt the low-reactance cable. Paired single-conductor cables should also be considered where low-current, long-time welding technique is used, particularly if cables are only a few feet long. Under these conditions, the kick does not spoil welds by throwing the gun out of position.

Table II—Factors Favoring Large or Small Gun-Welder Cables

	Large	Small
Those that depend on experience		
Lightness of gun-cable assembly	..	X
Ease of handling	..	X
Long copper life	X	..
Electrical economy	X	..
Calculable		
Minimum investment:		
Cable	..	X
Transformer and controls	X	..
Total	X	..
Cool cable	X	..
Hot weld	X	..

Fig. 2—Effect of grouping welds on equivalent welding rate



Since small cables can be used to carry low currents, the cable resistance is so high compared to the reactance that there is little to be gained by the use of low-reactance cables.

Thus the low-current, short-length job generally belongs to the common cable. Exceptions occur in certain multiple series spot welders where the space savings, lack of interference with adjacent cables and uniform distribution of current between the various electrodes make the low-reactance or duplex cable attractive.

The field of the low-reactance cable lies in most modern clamp guns and pinch guns and many older ones. Advantages of economy, consistent welds, greater production and operator satisfaction have made low-reactance cable practically standard where mechanical considerations permit its application.

Choice of Cable Size

Nearly the same number of active circular mils of copper are required for any given length of commercial type of cable to prevent overheating when making the same weld and having corresponding rates of water flow. But this factor is not usually important for ordinary cables, which are usually chosen oversize in an attempt to overcome the bottleneck that their high reactance presents to the desired large secondary current. Oversize cables naturally run cool. Therefore only one chart (Fig. 1) is presented for checking cable heating, and on it are shown sizes representative of the most commonly used low-reactance cables.

Values from this chart apply with reasonable accuracy to either interleaved or concentric duplex cables under conditions that result in a water flow of two gallons per minute. This is somewhat more than is usually run through the concentric type and is the minimum recommended for the interleaved designs. The minor corrections made for the differences in copper content, helix length and method of carrying water through the cable would seldom affect the choice of cable size for a given task.

In the few cases where it is desired to check the heating of ordinary cables, the multipliers shown on the chart may be used. These factors neglect the differences between lengths of actual conductors in the various types of cables and also the differentials in increase of resistance with age.

Fig. 1 is similar to an accurate nomogram that has been published previously.† The original chart used welding current, cable length and duty factor to establish cable size as determined by heating. This chart is correct and can be used for any welding conditions, provided the proper currents and duty factors are determined. For the great majority of portable spot welding, however, Fig. 1 will save computations and permit direct readings in terms familiar to maintenance and production men; *i.e.*, steel thickness and welding rate.

How to Use the Chart

Suppose, for instance, that 0.040-in. sheet steel is to be welded at 150 spots per minute with a gun at the end of a 6-ft. cable. What size cable is required for cool operation? On Fig. 1 lay a straight-

† The Welding Engineer, March, 1946, p. 56.

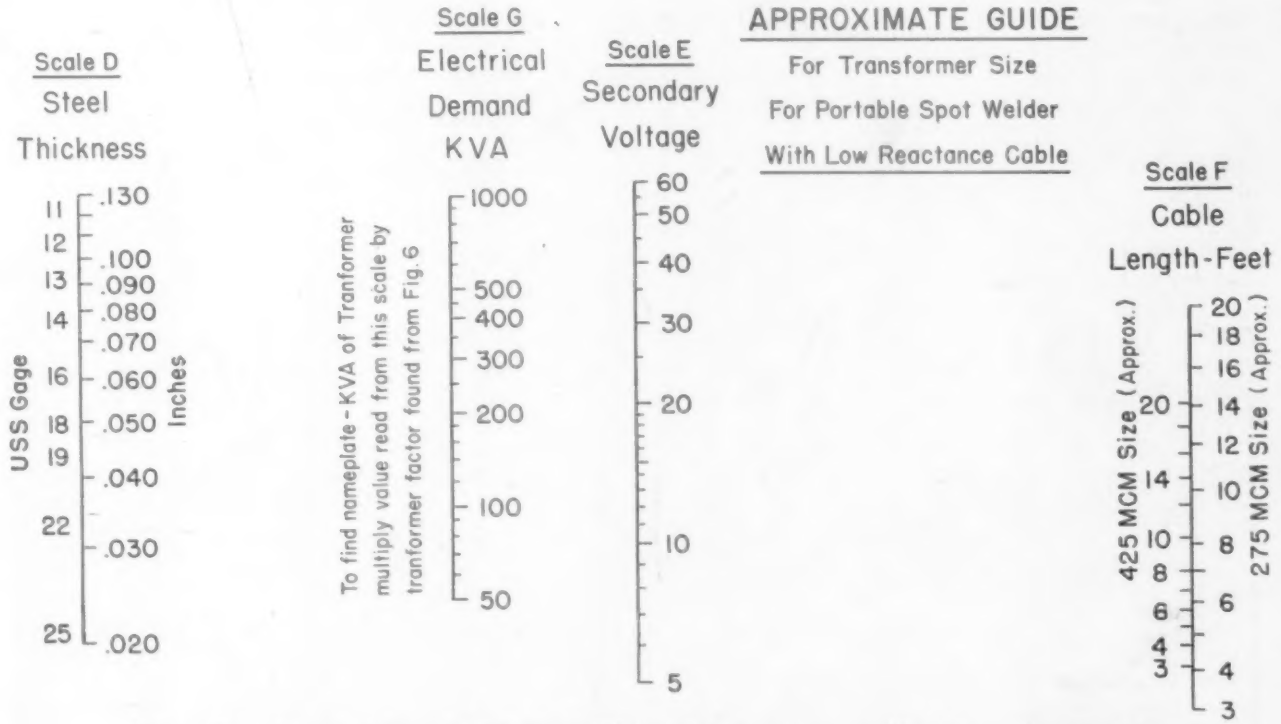


Fig. 3—Transformer chart, portable spot welder with low-reactance cable. Approximate guide to determine: (1) required open-circuit secondary voltage of transformer and (2) kva demand during each weld for welding clean low-carbon steel according to AWS current recommendations

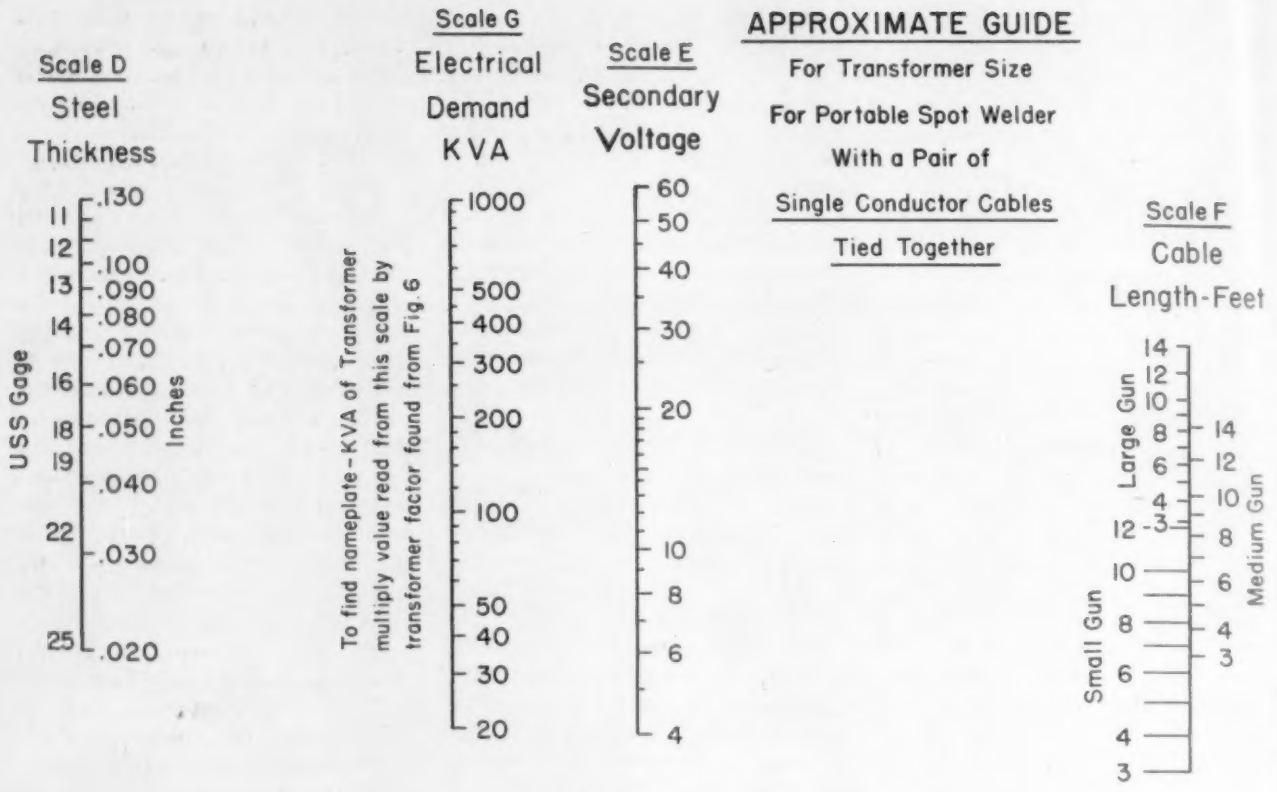


Fig. 4—Transformer chart for a pair of single-conductor cables tied together. This chart gives same data as Fig. 3, and same conditions apply, with the additional limitation of no magnetic material near cables. If there is, Fig. 5, which requires higher voltages for the same welds, will be more nearly correct for cables tied together

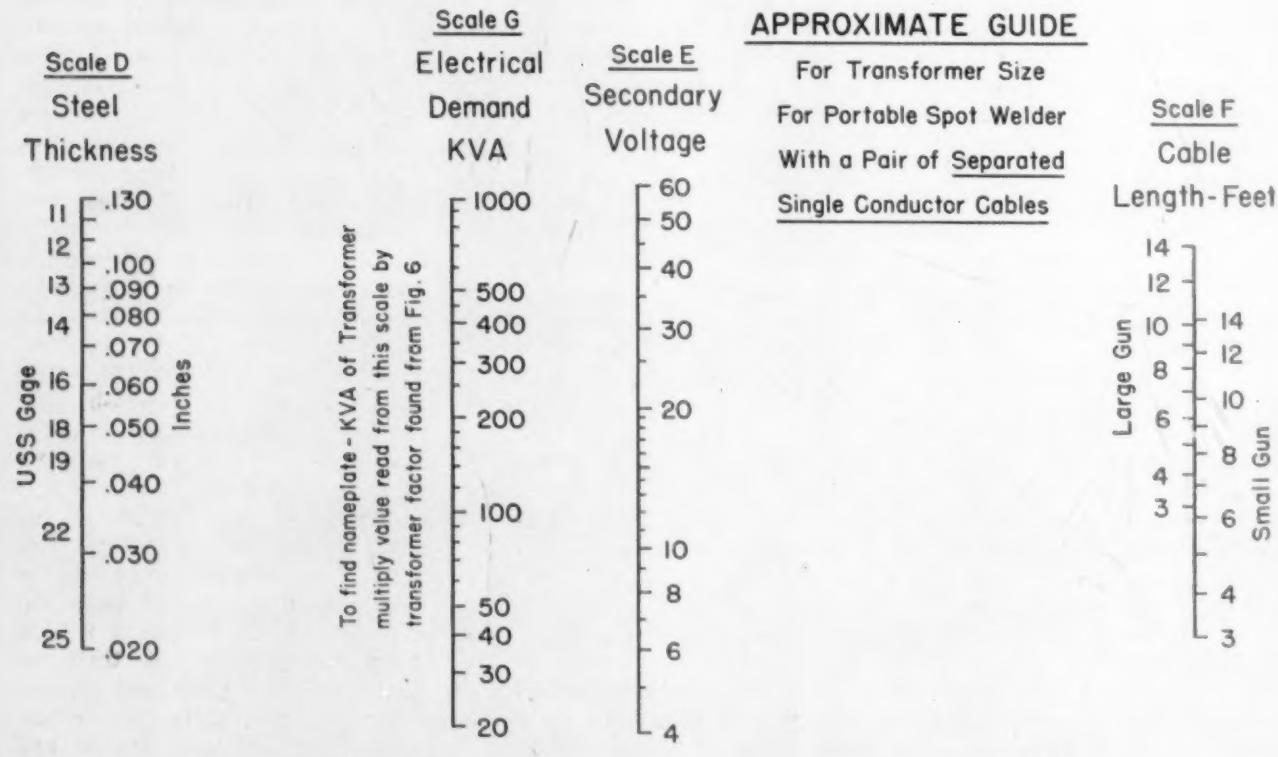


Fig. 5—Transformer chart for a pair of single-conductor cables separated by an inch or more. This chart gives the same data as Fig. 4 shows for cables tied together. For average-size guns, scale F, use intermediate values for voltage and kva

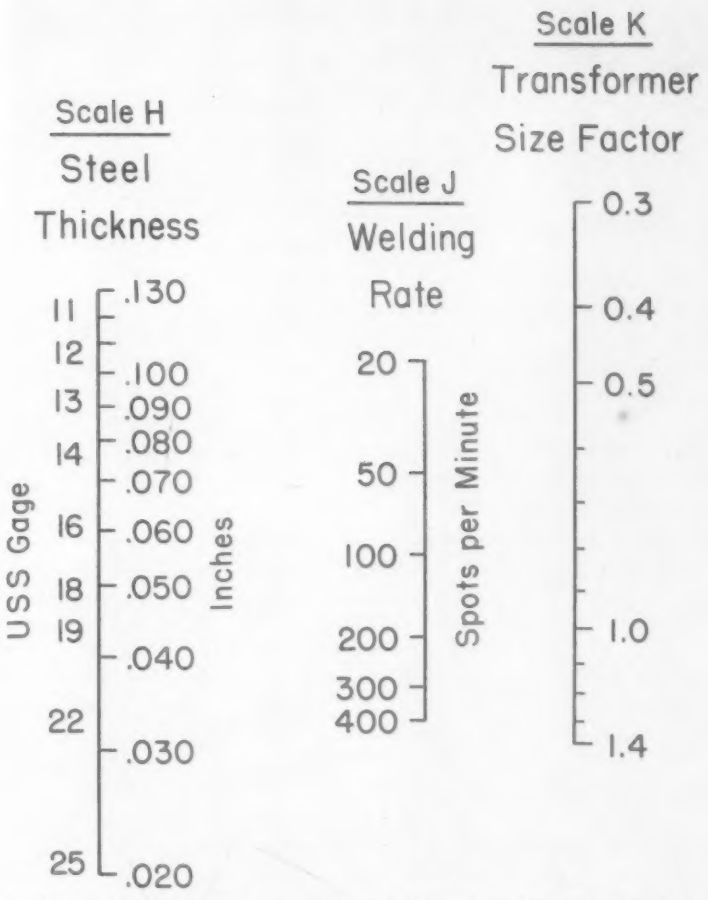


Fig. 6—Chart for transformer size factor. Use this chart with Figs. 3, 4 and 5

edge or draw a line between 0.040-in. on scale A and 6-ft. 275 mcm on scale C. The intersection of this line with scale B shows that such a cable is good for 220 spots per minute. Therefore, the 275-mcm cable will easily handle the 150 spots per minute.

The 400-mcm size of ordinary cables that would probably be used for the same work would have even more margin as far as cooling is concerned.

The interpretation of the "spots per minute" scale can have a great deal to do with getting correct results. Those who wish to consider that welding speed is simply the number of spots in the most active minute of production may do so and skip the following paragraphs. Such procedure will yield the right answer when welds are made continuously for about a minute and will sometimes be reasonably correct even when there are several rests per minute while the tool or work is being moved.

Since there may easily be a difference of two to one in the permissible welding speed shown by this method of averaging and another easy method, the latter is given here so that borderline cases can be checked more closely. This more accurate scheme is based on the relation

$$S = S_h F$$

where S = equivalent welding speed (spots per minute), S_h = welds per minute maximum (the rate at which welds would be made with the same timer setting if there were no rests for moving the gun or the work) = 3,600/total cycles per weld; F = group duty factor as read from Fig. 2. The latter chart is derived from "Rating of Electric Equipment under Intermittent Load," AIEE *Trans.*, 63:778 (1944).

Figuring Grouped Welds

As an example of the effect of grouped welds, consider the case of 150 assemblies per hour, each assembly having 12 welds made in 2 seconds. One weld requires 10 cycles, and hence the welds per minute maximum (S_h) = 360. The average number of welds per minute is 30, which is the figure that would be used on Fig. 1 by the man who has not read this far.

But the actual equivalent welding rate to use in choosing cable from the chart is 58. This is obtained by placing a straight-edge on Fig. 2, between 150 assemblies (groups) per hour and an active time of 2 seconds, noting that the straight-edge crosses the diagonal scale at the point 0.16 and multiplying 360 (S_h) by this factor. That is, the equivalent welding rate is 360 × 0.16 = 58—a far cry from the 30 "average."

So don't blame the chart if you figure a group-welding job by averages, and then find that the cable runs hot. The welding rate may be a lot higher than you thought. Other conditions must also be met: it is not the fault of the chart if the water supply to the cable is just a thin stream.

The other common question, "What will produce the required amount of welding current?", is not the right statement of the problem. The cable is simply a path; it produces no current but merely allows it to flow. The current "producer" is the voltage supplied by the transformer. Getting adequate welding current, therefore, may be considered as a matter of attaching a transformer with high enough secondary voltage. So we must turn to transformer computations.

Transformers are considered in this paper only because the correct size is one of the many essentials for getting satisfactory welds with any selected cable. The two points that bear on this relationship are the only ones considered here: the secondary voltage and the kva nameplate rating.

Transformers are chosen all too often by comparison with the size of transformer a pedestal-type welder would use for a similar job or by remembering what kva it took once before to weld the same gauge of steel. These mental processes may frequently lead to the wrong size because they do not consider the fundamental factors affecting the situation. The following charts, although of an

approximate nature, do take into account the most important of these points.

One set of charts (Figs. 3, 4, 5) shows the voltage required to produce the secondary current necessary to make the welds and also the kva demanded from the transformer during each weld. Figs. 4 and 5 are based on 500-mcm cables, but any usual size will require essentially the same voltage and kva in most cases. The other chart (Fig. 6) relates the kva demand to the nameplate rating of the transformer so that the heating effect may be taken into account.

A word of explanation may be necessary concerning Scale F in Figs. 4 and 5. "Small guns" mean those with about 6-in. throats; "large guns" those with about 30-in. throats. For average size guns in Fig. 5, read voltage and kva for small and for large guns and then use intermediate values.

To repeat, the purpose of Figs. 3 to 6 is to help select a transformer having: (*a*) high enough secondary voltage to send welding current through transformer, cable, gun and weldment and (*b*) sufficient size (kva rating) so the transformer will run cool.

To start with, the following decisions should already have been made: cable type, size, and length; size gun; metal thickness; welding rate (corrected for intermittent welding as discussed under choice of cable size). Then the following procedure is used to select the transformer:

Use of Transformer Charts

Step 1. Turn to Fig. 3, 4 or 5, according to the type of cable being used.

Step 2. Using a straight-edge between known values on scales D and F, find the secondary voltage where the line crosses scale E.

Example: With a gun-welder having a 6-ft, 275-mcm low-reactance cable, weld 0.040-in. mild steel. A straight line on Fig. 3, between 0.040-in. on scale D and 6 ft on the 275-mcm side of scale F, crosses scale E at 10.0 volts. Pick a transformer with a somewhat higher nameplate voltage.

Step 3. With the straight-edge in the same place as above, read the kva electrical demand from scale G. This tells *how much* power is drawn from the line during each weld, but transformer kva depends also on *how often* it is drawn. To find the effect of "how often," take step 4.

Step 4. On Fig. 6, from the known metal thickness, scale H, and the average welding rate, scale J, read the transformer size factor, scale K.

Step 5. Multiply the electrical demand by this factor. This gives the minimum kva transformer size for the welding work.

Example: Continuing the previous example, what kva transformer is needed for 120 spots per minute? Fig. 3 shows that for 0.040-in. steel and 6 ft of 275-mcm cable the electrical demand (scale G) is 90 kva.

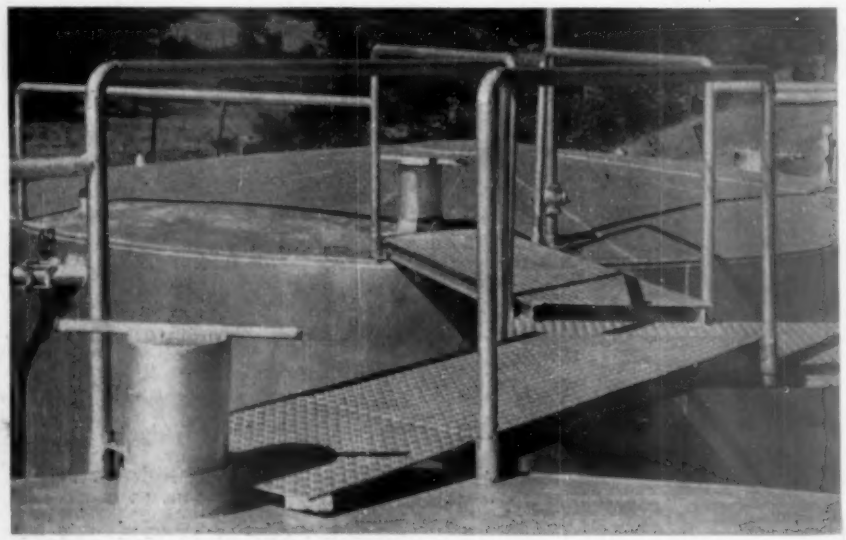
Fig. 6 shows that the transformer size factor for 0.040-in. steel, 120 spots per minute, is 0.8. Multiplying 90 by 0.8 gives 72 kva. A 75-kva transformer would be large enough for this particular set-up.

From the viewpoint of these charts, the rating of transformers by their open-circuit secondary voltage and secondary current capacity (rather than kva) would reduce the process of selecting size. The required secondary current rating of a transformer for a welding operation would be simply the current required for each weld, multiplied by the transformer factor from Fig. 6. This would not only be simpler but would give a more positive picture of the transformer characteristics, which a kva rating makes somewhat ambiguous.

To the man who is used to picking cable and transformer sizes for gun welders by rule of thumb, the answers will sometimes seem out of line. For instance, many men think it natural that larger cables and larger transformers should go together; however, the charts may call for larger transformers to accompany smaller cables. The reason for this is that smaller transformers cause greater demand on the electrical power supply.

All-Welded Guard Rails

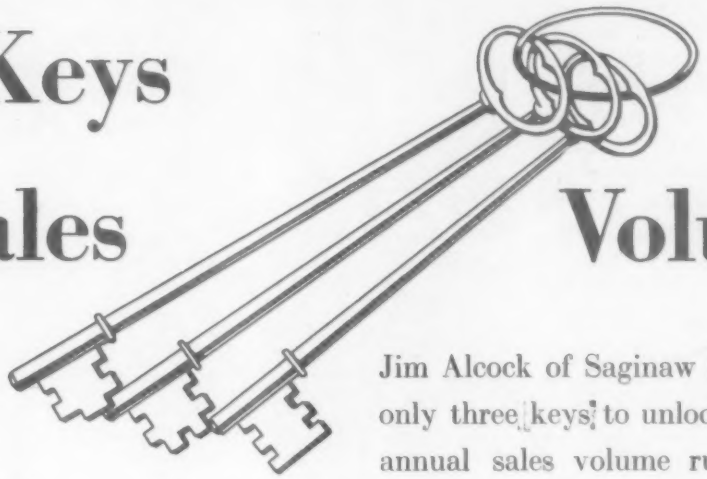
Even in guard rails, welding fittings are replacing screwed connections. The picture below shows the railings constructed for storage tanks in the W. H. Patterson operation in the Bradford, Pa., oil field. One-inch fitted elbows carry the tubular railing neatly around the 90-deg bends. The welded rails can't work loose and spill workers to the ground; they're also sturdier and better looking.



Courtesy Tube Turns, Inc.

Steel tubes connected by welding fittings make neat, sturdy guard rails

Three Keys to Sales Volume



Jim Alcock of Saginaw found he needed only three keys to unlock the door to an annual sales volume running well into six figures. They are all simple keys, too

BY T. B. JEFFERSON

After Paul Bunyan had cleared the Saginaw Valley of trees, the lumber camps moved out and industry began to move in. A valley that once had echoed the crash of falling timbers now began to resound to the tune of the hammer and the hum of machines. Skies that had been darkened with the smoke of burning brush were now aglow from the open fires of foundries and forges. The valley began to prosper and grow until the area from Flint to Bay City, Mich., became one large manufacturing center for the quantity production of automobiles, trucks, ships, boilers, construction equipment and other durable goods.

Salesman Turns Distributor

Such is the Saginaw Valley. And in this territory north of Detroit a cookie salesman by the name of Jim Alcock decided to handle welding equipment. Mr. Alcock had taken two years of business administration at Wayne University, supplemented this formal education by several years of selling in a retail department store as well as in selling gas heat and cookies. With this background he did not feel that the selling of welding equipment could be too tough.

For two years he covered the territory by working out of Detroit. Finally, in 1940, he opened a branch store in Saginaw, Mich., for a national distributor of welding gases and equipment. During the next two years he traveled through the valley, making the acquaintance of every potential user of welding equipment and pointing out to them how welding could be incorporated in the manufacture of their products. Each time that they listened to him a new user of welding was listed on the books.

Two years went by. On April 15, 1942, Alcock rented a small storeroom in Saginaw (Fig. 1) and started his own business, with his wife as a partner. He had only $1,500 in cash but many hidden assets—the ideas he had long been storing up in his head.

Alcock felt that most welding equipment distributors were overlooking a good bet by not properly advertising their commodities. He also felt that the average welding

Fig. 1—This small storeroom was the first home of Saginaw Welding Supply

Fig. 2—As the business grew, these larger quarters were required. Half of the front of this T-shaped building is office, the other half salesroom. In the rear there is a large stockroom and also an oxygen production plant

equipment distributor lost the opportunity to sell many more items than he was selling by failure to complete his line. In his own experience as a salesman, he had found that after selling a customer a cutting torch, for example, he was not in the position to follow through by selling him a portable grinder and grinding wheels; yet these items are generally used wherever a cutting torch is employed. As boss of the Saginaw Welding Supply Company, Alcock intended to correct this situation.

To his initial line of nationally advertised gas welding and cutting equipment, he added a line of nationally advertised d-c welders and electrodes and a supplementary line of a-c welders. Then he took on acetylene generators, industrial safety equipment, grinders, chipping hammers and small tools—in fact, practically any and every item that a job shop weldor might need.

The Business Grows

As a partner, Mrs. Alcock more than pulled her weight. She combined the functions of shipping clerk, stenographer and over-the-counter saleswoman, taking complete charge of the office while her husband hit the road. Before long their business had increased to the point where the one small salesroom proved to be inadequate. Likewise, there was more work than one man and one woman could do, so it became necessary to hire additional salesmen and clerical help and to obtain larger quarters. They therefore moved into the building shown in Fig. 2.

In planning his new quarters. Alcock considered his prime requirements to be adequate office space, a salesroom sufficient to display the equipment for sale and a large stockroom. His thinking along these lines followed the thoughts of most successful distributors: he wanted plenty of room to expand his office and sales force, sufficient space to display his products, a stockroom that would let him carry sufficient stock to meet customers' demands without robbing his display. All of these were essential and yet not enough.

Fig. 3—Counter displays and cutaway wall charts help boost sales

SWS Safety by SAGINAW WELDING SUPPLY CO. SWS
Borgstron HARD FACING ELECTRODES
Steody HARD FACING RODS
MID STATES ZIPPERETTE A.C. WELDER
Westinghouse ARC WELDERS and ELECTRODES
VICTOR WELDING-CUTTING EQUIPMENT
Miller A.C. FARM WELDERS
Lyon STEEL SHOP EQUIPMENT
RANDOLPH FIRE EXTINGUISHERS

Fig. 5—Practically everything that Saginaw Welding Supply sells is exhibited at county fairs. Here is a good example of how items are labeled

One of the things that Alcock soon learned was that he had not provided adequate wall space in his display room to take full advantage of manufacturers' sales helps. As a firm believer in the effectiveness of advertising, he appreciated the sales helps passed on to him and wanted to make the most of them. Consequently, some of the larger items on display in the salesroom became holders of sales kits for smaller items. Likewise, increasing advantage was taken of the counter as a means of display (Fig. 3).

He Also Advertises

The staff of the Saginaw Welding Supply Company is now comprised of Mr. Alcock as top salesman, Mrs. Alcock as office manager, an assistant general manager, a bookkeeper, a secretary, three salesmen and a store manager who handles over-the-counter sales. Alcock and his three salesmen travel within

Fig. 7—Many sales are consummated in this attractive, modern office

a 50-mile radius around Saginaw. The territory is vastly diversified, including on one hand a large manufacturer of motor cars and on the other many small farmers, with practically everything else in between these two extremes. To acquaint these varied customers with what it has to offer, the Saginaw Welding Supply Company makes effective use of many different advertising media.

One year's advertising budget, for example, included 100,000 books of matches, 50,000 scratch pads (serving as a constant reminder in the office) and 5,000 welding caps. The caps called attention to the Saginaw Welding Supply in every shop throughout the territory. Such items as playing cards and knives bearing the Saginaw Welding Supply name have also been passed out on special occasions. More formal newspaper advertising (Fig. 4) appears regularly on Wednesdays and Sundays in the leading Saginaw paper and on occasions in other papers. While this advertising program would probably seem enough to many welding distributors, Alcock supplements it with spot radio announcements on Sunday evenings immediately following the Jack Benny program.

Come to the Fair

During the fair season, Saginaw Welding Supply exhibits in all of the major county fairs in its sales territory. This has proved so effective that Mr. Alcock has had difficulty in determining which is the most profitable—his county fair exhibits or his newspaper advertising. He knows that he needs them both, but he had often wondered which one does the most good . . . The question has never been satisfactorily settled.

Alcock definitely knows that his exhibits at the fairs have materially increased his sales of welding equipment. The effectiveness of farm exhibits has also been accepted by his competitors. In 1943, Alcock was the only welding exhibitor at the Saginaw County Fair, but he no longer has the field to himself. Last year most of his competitors in the welding field were also fair exhibitors. Though others are out to get their share of the business that the Saginaw Welding Supply Company has been capturing in rural areas, Alcock is not worried by their efforts. There seems to be plenty of business to go around, he thinks; at any rate he has not yet felt the effects of competition. Moreover, he feels that clean competition keeps him on his toes and that it will eventually make for more business for everybody in the welding field.

Saginaw Welding Supply now regularly exhibits at three county fairs. Typical booths are shown in Figs. 5 and 6. These are planned to show what the company has to sell and to attract attention by unusual welding or flame-cutting applications.

Farmers are invited to bring in broken equipment to be welded during fair week. The boys in the tent are thus given the opportunity to try their hands at many different problems, and the amount of good-will built up is almost incalculable. To do a tough repair job successfully while the eyes of many farmers are focused on you is a sure way to win converts.

In getting ready for a fair, Alcock and his helpers go in the stockroom and pick out as many different items as they feel can be adequately displayed. Most of the items are of such a size that they can't be picked up easily as "souvenirs" by the fair customers. After the exhibit has been unloaded, the price of each item is marked in large chalk figures so that everyone can see just how much it sells for. Any item on exhibit is for sale.

On only a few occasions has Saginaw Welding taken home anything on the Saturday night the fair closed. As a rule everything has been sold, including the demonstrator welder, so that all that has to be taken back home are the exhibit signs—and filled order books.

It has been difficult to measure the results of these county fair exhibits because they extend over so long a period. For as long as 10 months after a fair, someone will write in to ask for a particular item exhibited. Sales on this basis have been made to points as far distant as Tampa, Fla., and Colorado.

Annual sales volume has increased from nothing to a figure that runs into six digits. Despite a heavy working program, however, Jim Alcock does not spend all of his time selling welding equipment. He has served as chairman of the Saginaw Valley Section, American Welding Society, and as president of the Saginaw Exchange Club and is active in the Saginaw Valley Purchasing Agents' Association as well as other local organizations.

In his promotion of welding and safety in industry, he has taken an active part in the activities of the Saginaw Industrial Safety Council and the Lansing Safety Council.

He firmly believes that these extra-curricular activities, plus effective advertising and effective merchandising of the welding equipment he has to sell, have been responsible for his success as a welding distributor.

Not Fenced in

Never one to let any grass grow under his feet, Alcock realized early that many fellows distributing welding equipment were overlooking a good bet in not carrying all of the items usually needed. He supplements his lines of welding equipment with many other items that are used in the welding shop, letting the shop owner look to him as the source of supply for everything. Another profitable item, though little used in the welding line, is carried because of chance. The manufacturer of the gas welding rods he sells also makes an industrial wire fence. Since distribution was needed in the Saginaw area, Alcock took on this product and found himself a fencing contractor. This side venture is a money maker and takes little time away from the welding business.

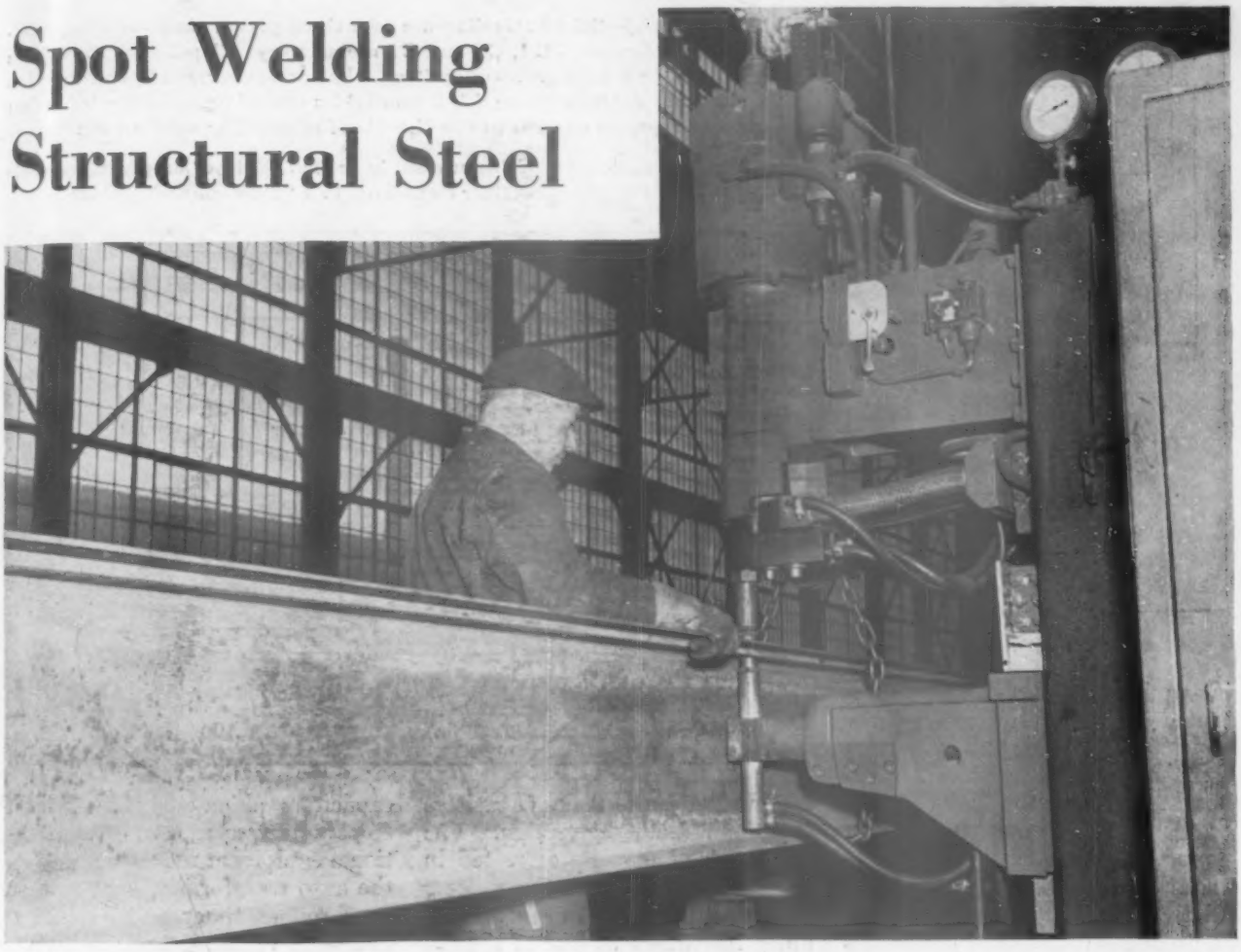
Let's cite an incident that happened last fall. While he was in the hospital, recuperating from an illness, Alcock noticed that men were working outside his room, laying a concrete foundation for a tennis court for hospital employees. Alert to every opportunity, he asked the nurse to have the purchasing agent for the hospital come and see him. He found that the hospital was very much interested in chain link fencing for the tennis court and was wondering when delivery could be obtained. Picking up the phone beside his bed, Alcock immediately placed a long-distance telephone call to Pittsburgh. He found out that immediate delivery could be obtained, and the sale was made; the commission more than paid for the hospital bill.

Alcock feels that the keys to successful welding distributor operations are: (1) adequate stock and displays, (2) adequate advertising, and (3) publicity through public service. He has tried all three.

Fig. 4—These are samples of the type of ads which appear in the newspapers serving the Saginaw Welding Supply Company's trading area. Note that other items than simon-pure welding equipment are advertised

Fig. 6—Prices are marked in chalk on the items outside the tent. Farmers note the prices, find the equipment within their means. If the price were not visible, the farmer might hesitate to consult a salesman

Spot Welding Structural Steel



Spot welding a ¼-in. plate to a 14-in. I-beam. No preweld cleaning was done to remove the scale and rust

★ CONSTRUCTION

Spot welding is satisfactorily replacing other fastening methods in the structural steel field. A Chicago iron works feels that it offers good possibilities and recommends its use.

For the past six months a Chicago iron works has been using resistance welding in the fabrication of many structural items such as trusses, spandrel beams, columns, brackets and similar items. This Chicago concern has been fabricating structural steel for many years and has learned to lean more and more upon welding as a means of metal joining. Arc welding began to replace rivets in structural fabrication as long ago as 1924 in this shop, which is now finding in spot welding an additional tool for builders.

In planning its new construction method, not yet ready to be publicly announced, the company felt that if spot welds could replace rivets, production speed could be materially increased without sacrifice of strength in any way. The increased speed, however, would depend on whether or not it would be possible to eliminate postweld cleaning without losing the time thus gained in preweld cleaning and other preparation for welding.

Why Postweld Cleaning?

By way of additional explanation, structural steel has always had to be cleaned prior to welding because it is covered with loose mill scale. Postweld cleaning has likewise been necessary because there is a definite tendency for the paint to break down when welded joints have not been adequately cleaned to remove the chemicals of the welding flux. Nothing can possibly be more discouraging to the structural fabricator than to inspect a finished fabrication sitting in his yard and find a bright red glow of rust outlining each weld joint. This unhappy condition appears, however, whenever postweld cleaning has not been done satisfactorily.

Resistance welding, requiring no flux, is able to do away with the need for postweld cleaning and assure perfect paint jobs. But there were other serious problems ahead in the use of spot welding, most of them posed by the source of electrical energy.

The operation of resistance weld-

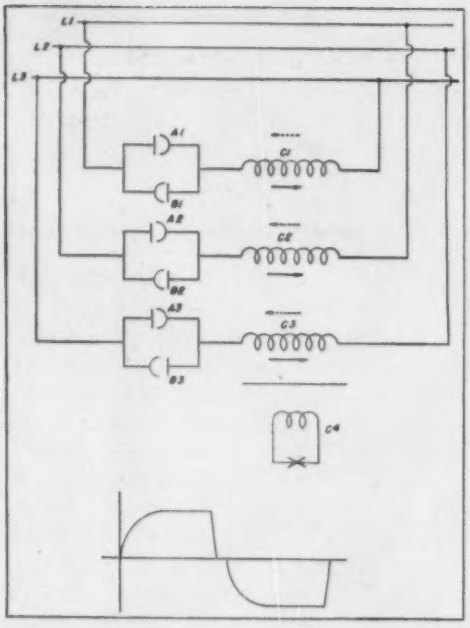
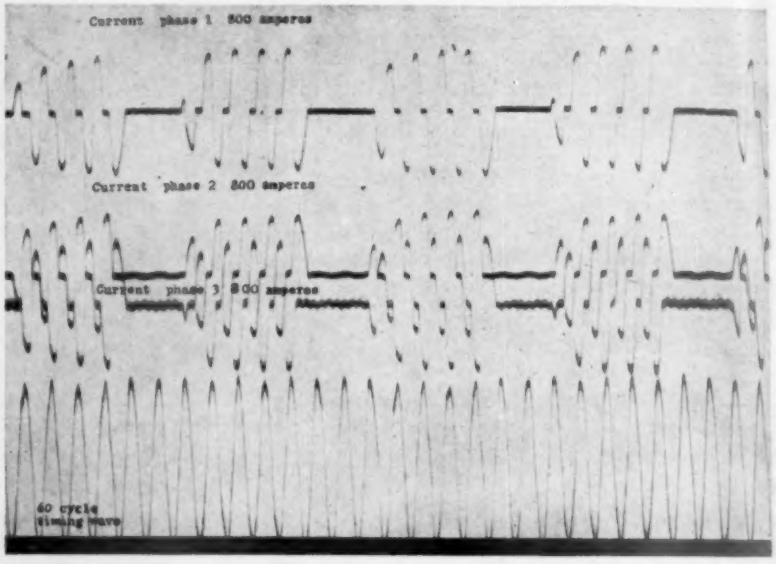


Fig. 1 (left)—Schematic diagram of a three-phase, three-winding welding transformer. C 1, C 2 and C 3 are primary coils; C 4 the secondary; A 1, A 2 and A 3 a group of ignitrons that passes current in the direction shown by dotted arrows; B 1, B 2 and B 3 a second group of ignitrons that passes current in the direction indicated by solid arrows

Fig. 2—Oscillogram of line current in each of the lines supplying a double three-phase rectifier connected to a "three-phase" welder



ing-equipment has always presented a serious problem from the viewpoint of the public service company supplying power. This has been due to the fact that the ordinary welder operates at low power factor, usually below 30%, and has a high kva demand for relatively short periods of time. It produces unbalanced conditions in the three-phase supply because of single-phase load resulting in disturbances in the voltage conditions on the three phases.

A number of systems have been devised with the object of reducing the demand on the power supply and improving the power factor. One of these systems makes use of a motor-generator set with a large flywheel on the shaft so that there is a great deal of energy storage which tends to soften the kick of the welder load on the line. The motor is a high slip type operating from the three-phase line. The generator may be wound for low frequencies so as to take advantage of the lower secondary impedance and resulting lowered demand of a welder operating at low frequencies. Systems of this type, where the generator delivers power to a welder at frequencies of 16⅔ cycles per second, were successfully installed in France. The system has one great disadvantage in that the initial cost is very high.

Another system in popular use is the installation of series capacitors for power factor correction. The welding load may be corrected in this manner so that the system operate at a power factor of near unity instead of at one of around 30%. Kva demand is reduced in proportion.

Cost of Series Capacitors

A system of this type requires the use of additional equipment: a bank of series capacitors, an auto transformer, high-voltage synchronous control equipment, a discharge resistor to discharge the series capacitors, overvoltage protective equipment and cabinets for housing. All of this adds to the original cost. A welding transformer wound for the nominal line voltage may be used in conjunction with an auto transformer, or the welding transformer may be wound for the high voltage required by the use of series capacitors. In the case of a welding transformer having a power factor of 25%, the voltage would be around 1,800 in the event that the power supply was 460 volts.

The total cost of installing series capacitor correction equipment runs rather high. The cost of capacitors alone will be at least $4 per uncorrected kva. The additional equipment required—that is, the auto transformer, high-voltage synchronous timer and contactor, discharge resistors, and high-voltage protective equipment—will increase the cost of the complete installation by approximately $4,800 for a machine having a peak demand of 500 kva with a power factor of 25%. Furthermore, the demand is still on a single phase after the correction is realized, thereby unbalancing the three-phase system. Another disadvantage is that extreme safety precautions must be observed in the installation and operation of a machine of this type since the voltage across the primary of the welding transformer and across the series capacitors may run as high as 1,800 volts.

The stored-energy type of apparatus allows the use of direct current for performing the welding operation, and the rectifiers used in this type of equipment can be very readily made to operate from a three-phase power supply. This type of equipment is entirely satisfactory for the welding of aluminum and other materials requiring high-peak currents of short

duration, but it is not very satisfactory for the welding of steel.

Balanced Load on Three Phases

Another form of a three-phase welder is illustrated diagrammatically in Fig. 1. This type of apparatus eliminates the use of a separate rectifier because both the rectification and transformation are realized on one iron core by the use of a patented principle. The welding transformer is made with three separate primary windings and one low-voltage secondary.

Referring to Fig. 1, we see three groups of primary coils: C 1, C 2, C 3—secondary C 4—and two sets of ignitron tubes: group A 1, A 2, A 3, and group B 1, B 2, B 3. By suitable control means, ignitrons A 1, A 2 and A 3 are allowed to become conductive for a preset interval of time, thus allowing electron current to flow in turn through coil groups C 1, C 2 and C 3 in the direction shown by the dotted arrows. The increase of magnetic flux in the iron core will induce in the secondary circuit of the welding machine a d-c current of a duration that can be set up to 12 cycles before saturation is reached in the magnetic core. Thicknesses of metal ranging up to ⅛ plus ⅛ in. can be welded with this flow of d-c current wave. In order to desaturate the iron, the next welding pulsation is reversed by rendering ignitron group A nonconductive. Ignitron group B is rendered conductive for the same period of time, thus allowing current to flow in the direction indicated by the solid arrows.

In the case of pulsation welding for thicknesses ranging above ⅛ in., as for structural steel, the current in the primaries reverses its direction at a predetermined rate, and the magnetic field in the core reverses its direction at the same rate. Since the secondary is wound upon the same core and is also affected by the magnetic field, a voltage will be generated in the secondary which will force through the secondary circuit a current having the characteristics of a d-c welding system.

It is very evident that there are distinct advantages to welding with direct current. For instance, the skin effect increases the resistance in the secondary circuit to 2.3 times the d-c value when we operate on 60 cycles. Moreover, the steel plates in the throat of a welder operating with d-c have very little effect upon the current passing through the secondary circuit, making it unnecessary to place current-compensating devices on a welder of this type.

The rectifiers which are used for the production of direct current for this type of equipment are inherently high power factor devices. Three-phase rectifiers with anode transformers operate at power factors in the neighborhood of 80%; double three-phase rectifiers, using an interphase transformer, operate at a maximum of 95.5% power factor with very high efficiencies. Identical current is supplied in each of the three lines, which means that the heating effect is the same on each and that the power distribution equipment is evenly loaded on all three phases.

It might be interesting to look at Fig. 2, an oscillogram of the line current in each of the lines supplying a double three-phase rectifier connected to a "three-phase" welder. We can see from the curves that there is not a single high-current transient on the line. This favorable operation exists regardless of whether we use synchronous timing equipment or non-synchronous relays to control the firing of the rectifiers for each impulse.

Table I. Welding Program for ⅝ to ⅝ in. Scaly Steel

	Preheat	Welding	Quench	Annealing	Forging
Pressure	23,530	19,910	23,530	23,530	23,530
Current	47,000	78,500	0	78,500	0
Time	6 sec	5.46 sec	3.95	1.5	1.5
Kva demand	230	532	0	532	0

Requires Lesser Power

The power required to weld the same material is less with the three-phase type of welder than with standard single-phase, 60-cycle equipment. We can see why this is true if we will examine the conditions under which a welding machine must operate.

The usual welder has a throat depth of somewhere around 24 in. and is operated with spacings 8 to 10 in. between the horns. Under these conditions, the secondary imped-

Fig. 3—Weld test sample of ¼ to ¼ in. clean mild steel

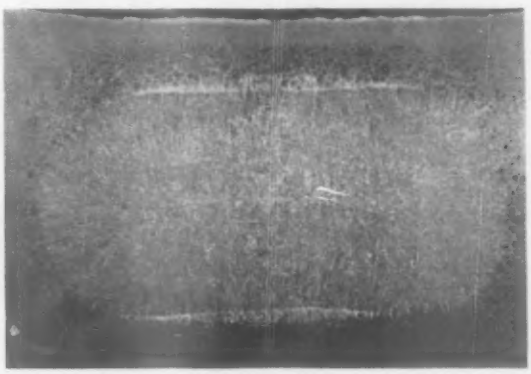


Fig. 4—Macrograph of a spot weld on rusted and scaly low-carbon steel, 5/16 to 5/16 in.

Fig. 5—This two-weld specimen on ⅝ to ⅝ in. structural steel (0.15% C) showed a tensile strength of 143,550 lb.

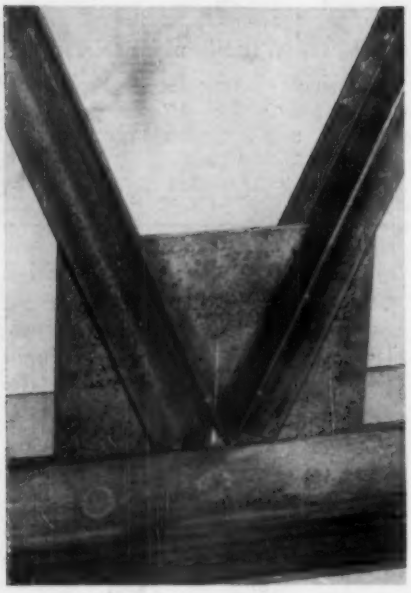


Fig. 6—This truss connection illustrates how spot welding is being used to replace rivets in the assembly of steel structures. Note how the gusset is employed

ance is somewhere in the neighborhood of 330 microhms. The power required to pass a specified current through the secondary is proportional to the square of the current and to the impedance of the secondary circuit. In the case of the welder with a 24-in. throat, the power required would be $I^2 \times 330$. But if we operate the very same welder by passing direct-current through the secondary, the power required will be very close to $I^2 \times R_{d\text{-}c}$, and the d-c resistance of a welder of this type would be somewhere in the neighborhood of 25 microhms. This indicates that the power required would be proportional to $\frac{330}{25}$ or 13.2. Hence the power required by a-c single-phase equipment would be 13.2 times greater than that needed by the d-c or three-phase equipment.

Even though the power requirements between the single-phase and three-phase systems are not actually in the ratio of 13 to 1, we may still effect substantial savings in power by using the three-phase welding apparatus. For example, tests were conducted in the welding of ¼ plus ¼ in. clean mild steel (Fig. 3) on three-phase equipment. The single-phase welder demands 255 kva whereas the three-phase welder demands slightly less than 100 kva in performing the same welding operation. This is a ratio of 2.55 to 1. The line current on single phase was 535 amp as against 120 amp for the three-phase welder —a ratio of 4.36 to 1.

Rusty and Scaly Stock

By the correct use of a suitable current and pressure cycle, the need for cleaning or pickling the usual rust and scale present on hot-rolled structural steels may be eliminated. The cycle is divided into six parts: (A) a preweld period of high electrode pressure, wherein the scale is partially broken to establish surface contact; (B) a period of low current combined with high pressure to melt the surface oxides; (C) a third preweld period of high current, high pressure to insure proper fit of the parts before welding; (D) the actual welding period, in which pressure is reduced for higher efficiency; (E) a quick follow-up with the high pressure before interruption of the current to prevent the development of internal cracks; (F) a final forging action just before the "off time." The entire cycle is automatic and is controlled by preset electronic timers.

A complete welding program suitable for the welding of scaly material includes descaling, preheating at high pressure and low current, welding at low pressure and high current, quenching, annealing at high pressure and high current, and forging. In the welding of ⅝ to ⅝ in. scaly steel, for examples, the program shown in Table I was utilized.

Fig. 4 shows a macrograph of a spot weld joining two 5/16-in. angles of low-carbon, hot-rolled steel that was badly pitted, rusted and scaly. The weld nugget is of the proper size and penetration.

Shear strengths are very great on the heavier thicknesses. Fig. 5 pictures a two-weld specimen of ⅝ to ⅝ in. plate that showed a tensile strength of 143,500 lb.

An excellent example of how spot welding is being utilized to replace rivets in the assembly of structural steel structures is provided by Fig. 6. Speeds of from 2 to 25 spots per minute can be attained, depending upon the gauge of material and degree of scale.

The shear values for various thicknesses of both steel and aluminum are tabulated in Fig. 7, which also gives four simple formulas to use in determining the best values for weld nugget diameter minimum spacing, distance from center of weld to edge of plate and minimum of lap.

In conclusion, it is stated that the three-phase equipment has distinct advantages over single-phase equipment in that:

1. The power demand required to perform a specific welding job is lowered substantially.
2. The line currents in the three-phase system run from ¼ to ⅙ of that found in using single-phase equipment for machines having throat depths normally used.
3. The line currents on each of the three lines supplying a three-phase welder are identical, thus producing uniform heating effects on all three lines and on all three phases of the distribution transformers and system.
4. There is no high current transient at the start of each impulse when non-synchronous control equipment is used on three phases.
5. Secondary current remains the same, whether or not heavy steel sections are introduced into the throat of the machine.
6. Installation costs of extra equipment, switch gear and wiring are reduced.

STEEL		ALUMINUM	
THICKNESS	SHEAR	THICKNESS	SHEAR
⅛ IN	6100 LB	081 IN	1800 LB
¼ "	17000 "	125 "	3000 "
⅜ "	33000 "	156 "	4500 "
½ "	62000 "	187 "	6500 "
⅝ "	83000 "		
¾ "	113000 "		

t = THICKNESS OF MAT'L.
S = MIN. SPACING.
D = DIAMETER OF SLUG.
E = DISTANCE FROM CENTER OF WELD. TO EDGE.
L = MIN. OF LAP.

ALUMINUM	STEEL
D = 4t	D = 2t + ⅛
S = 15t	S = 12t
E = 6t	E = 5t
L = 2E	L = 2E

Fig. 7—Shear values for various thicknesses of steel and aluminum. Spacing, edge distance, minimum lap and weld nugget diameter can be determined by the four empirically derived formulas given

Torch Brazing Aluminum-I

★ PRODUCTION

This two-part article is one of the most meaty discussions of aluminum brazing that has come our way for a long, long time. The present installment covers the advantages of the process, types of aluminum alloys, joint strengths and corrosion resistance, design problems, jigs, fixtures and positioners.

BY HARRY A. HUFF
Welding Specialist,
Air Reduction Sales Co.

UNTIL recently brazing has not been used to any great extent in joining aluminum owing to a lack of suitable filler metal and flux materials. Proper filler metal and flux materials, developed after extensive laboratory and field researches, are now commercially available and open up such new and interesting possibilities as:

(*a*) The joining of complicated assemblies, thin sections, etc., which it has not been possible or commercially practicable to join.

(*b*) Lower joint cost;

(*c*) Speed, precision and ease of joining, permitting the use of less highly skilled labor and wider applications of mass-production, assembly-line methods;

(*d*) Simplification of design and improvement in overall physical appearance by the elimination of non-essential bolts, rivets, etc.

There has been much discussion about an adequate definition of brazing. So many conflicting views were presented that it appeared for a time that a satisfactory solution was almost unattainable. Present thinking seems to indicate that brazing will be considered as a separate and distinct metal-joining process on a par with welding rather than as a process subordinate to welding, as heretofore considered. While no official pronouncement has come from the committees considering this matter, the following definition is believed to reflect current consensus of opinion:

BRAZING: a group of metal-joining-processes wherein the metals to be joined are heated to temperatures below their respective melting points or ranges and a non-ferrous filler metal having a melting point or range of not less than 800 F is used.

(Headpiece) Aluminum furniture is becoming increasingly popular for restaurants, lounges, cocktail rooms, etc. This operator of Solar Craftsmen Furniture Co., Inc., uses the torch-brazing process to oin the combination leg and hand grip section of a product called the "step-up"

The above definition corresponds roughly to the one in the 1942 AWS Handbook except for a lower melting-point value of the filler metal. It distinguishes brazing from welding, wherein the metals to be joined are heated up to or above their melting points, and from soldering, wherein a filler metal (or solder) having a melting point lower than 800 F is used.

Brazing methods are commonly distinguished from one another according to the manner in which the brazing heat is applied. The principal methods are: furnace brazing, wherein the brazing heat is applied by placing the parts or sections to be joined in a furnace; dip brazing, wherein the parts or sections are brought up to the braz-

ing temperature by being dipped in a bath of molten flux; torch brazing, wherein the necessary heat is supplied by means of a torch; and induction brazing, wherein the heat is induced by means of high-frequency electric current. Such other methods as tong brazing and spot brazing are primarily resistance-welding processes and need not be considered in this article. Insofar as the brazing of aluminum is concerned, the methods most commonly employed are furnace brazing, dip brazing and torch brazing.

Although each method has its inherent advantages and disadvantages, the method with which this discussion is primarily concerned is torch brazing. This is reputed to be the first method tried in the brazing of aluminum and the most versatile and economical method in all-around fabrication and repair service.

Types of Aluminum

The single term "aluminum" is customarily used to refer both to pure aluminum and to aluminum-base alloys, except where it is desired to distinguish one from another.

The torch-brazing procedures discussed apply particularly to the four types of wrought aluminum coming within the chemical limits listed in Fig. 1. These four types comprise the standard wrought alloys thus far most commonly and successfully brazed and, in the order listed, are known by trade designations 2S, 3S, 53S (or R353) and 61S (or R361). Pure aluminum and high-purity aluminum —*i.e.*, any wrought aluminum of higher purity than "commercial aluminum" (2S)—may be brazed with the same facility, by the same procedure and with the same filler metals and flux as recommended for 2S, which is classified as type 1, Fig. 1.

A wrought product known as "aluminum brazing sheet" consists of sheet aluminum (in any one of three compositions) coated on one or both sides with a suitable filler-metal alloy to eliminate the need for adding filler metal during the brazing operation. This sheet is also commonly used in brazed assemblies and, with certain precautions, can be torch brazed, although it is primarily intended for furnace and dip brazing.

Certain other types of aluminum, including both wrought products and castings, have been brazed experimentally, but standard commercial procedures for dealing with them are still largely in process of development. Before attempting to braze types of aluminum not herein described, it is advisable to consult with the producers.

Heat-Treatment Grouping

On the basis of their relative response to thermal treatments (which response is a factor of their respective chemical compositions), wrought aluminum alloys are divided into two groups: (*a*) non-heat-treatable and (*b*) heat-treatable. The non-heat-treatable group, types 1 and 2, can be improved in mechanical properties (strengthened, hardened, etc.) only by means of cold work. The heat-treatable group, types 3 and 4, can be mechanically improved by both cold work and heat treatment.

Designations used to denote tempers produced in the two groups are as follows:

(*a*) Non-heat-treatable group (types 1 and 2):
F—As fabricated;
O—Annealed or soft;
¼ H—One-quarter hard;
½ H—One-half hard;
¾ H—Three-quarter hard;
H—Full hard.

TYPE NUMBER	1		2		3		4	
TRADE DESIGNATION	2S		3S		53S or R353		61S or R361	
CHEMICAL COMPOSITION (%)(a)	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Aluminum	99.0	-	Remainder		Remainder		Remainder	
Chromium	-	-	-	-	0.15	0.35	-	0.35
Copper	-	0.20	-	0.20	-	0.10	0.15	0.40
Iron	-	(d)	-	0.70	-	0.35	-	0.70
Magnesium	-	-	-	-	1.1	1.4	0.80	1.2
Manganese	-	0.10	1.0	1.5	-	0.10	-	0.15
Silicon	-	(d)	-	0.60	-	(e)	0.40	0.80
Titanium	-	-	-	-	-	(f) -	-	0.15
Zinc	-	0.10	-	0.10	-	(f) 0.10	-	0.10
Other Elements - Each	-	0.05	-	0.05	-	0.05	-	0.05
" " - Total	-	0.15	-	0.15	-	0.15	-	0.15
HEAT-TREATABLE?	No		No		Yes		Yes	
FORMS & TEMPERS PRODUCED								
Plates-Bar-Rod-Shapes	O & F		O & F		O, W, & T		O, W, & T	
Sheet-Pipe-Tubing-Wire	O to H inclusive		O to H inclusive		O, W, & T		O, W, & T	
Forgings	Not Produced		Not Produced		T		Not Produced	
Castings	Not Produced		Not Produced		Not Produced		Not Produced	
TYPICAL PROPERTIES (b)								
Yield Strength (p.s.i.)	5000 (O temper)		6000 (O temper)		7000 (O temper)		8000 (O temper)	
" " "	21000 (H ")		25000 (H ")		33000 (T ")		40000 (T ")	
Ultimate Strength (p.s.i.)	13000 (O ")		16000 (O ")		16000 (O ")		18000 (O ")	
" " "	24000 (H ")		29000 (H ")		39000 (T ")		45000 (T ")	
Shear Strength (p.s.i.)	9500 (O ")		11000 (O ")		11000 (O ")		12500 (O ")	
" " "	13000 (H ")		16000 (H ")		24000 (T ")		30000 (T ")	
Endurance Limit (p.s.i.)	5000 (O ")		7000 (O ")		8000 (O ")		9000 (O ")	
" " "	8500 (H ")		10000 (H ")		13000 (T ")		13500 (T ")	
Hardness (Brinell)	23 (O ")		28 (O ")		26 (O ")		30 (O ")	
"	44 (H ")		55 (H ")		80 (T ")		95 (T ")	
Elongation (% in 2")	45 (O ")		40 (O ")		35 (O ")		30 (O ")	
"	15 (H ")		10 (H ")		20 (T ")		17 (T ")	
Melting Range (°F.)	1190 to 1215		1190 to 1210		1075 to 1205		1080 to 1205	
FILLER METAL TO BE USED (c)	#26 or #716		#26 or #716		#716		#716	
BRAZING TEMPERATURE (°F.)								
Using #26 Filler Metal	1160 to 1185		1160 to 1185		----		----	
Using #716 Filler Metal	1060 to 1090		1060 to 1090		1060 to 1090		1060 to 1090	
SPECIFICATIONS PERMITTING SIMILAR BUT NOT NECESSARILY IDENTICAL COMPOSITIONS								
A. S. T. M.	B25-44T (A2)		B79-44T (M1)		-		-	
"	B178-44T (A2)		B126-44T (M1)		-		-	
Army	AAF-11077		-		-		-	
Army/Navy Aeronautical	AN-A-20		-		-		-	
" "	AN-QQ-W-298 (2S)		-		-		-	
Federal	QQ-A-411b		QQ-A-356b		QQ-A-331b		QQ-A-325	
"	QQ-A-561		QQ-A-359a		QQ-A-334		QQ-A-327	
"	WW-T-785a		WW-T-788a		QQ-A-367b (C1.8)		WW-T-789	
"	-		-		WW-T-790		-	
Navy	43R5e (Gr.A)		43R5g (Gr.B)		43R5g (Gr.E)		-	
"	44T19c		44T20b		44T30a		-	
"	46A3e		46A6e		46A7d (Gr.B)		-	
"	47A2e		47A4d		46A10b		-	
"	47A5b (Gr.A)		47A7		47A12a		-	
S. A. E. - A. M. S.	4001, 4003,		4006 & 4008		4076A		4025, 4026,	
" "	4062, & 7220A		-		-		4027, 4080B,	
" "	-		-		-		4082B, & 4150	
" - Handbook	25		29		282		281	

(a) Based upon data published by Reynolds Metals Company.
(b) Based upon data published by Aluminum Company of America (all values are approximate).
(c) Filler metal numbers are designations of Air Reduction Company.
(d) Iron plus silicon 1.00% maximum.
(e) 45-65% of magnesium content.
(f) Forgings and forging stock may have titanium 0.15% maximum and zinc 0.25% maximum.

Fig. 1—Compositions, forms, tempers and physical properties of the four most commonly brazed aluminum alloys

(*b*) Heat-treatable group (types 3 and 4):
O—Annealed or soft;
W—Solution heat-treated;
T—Solution heat-treated and aged.

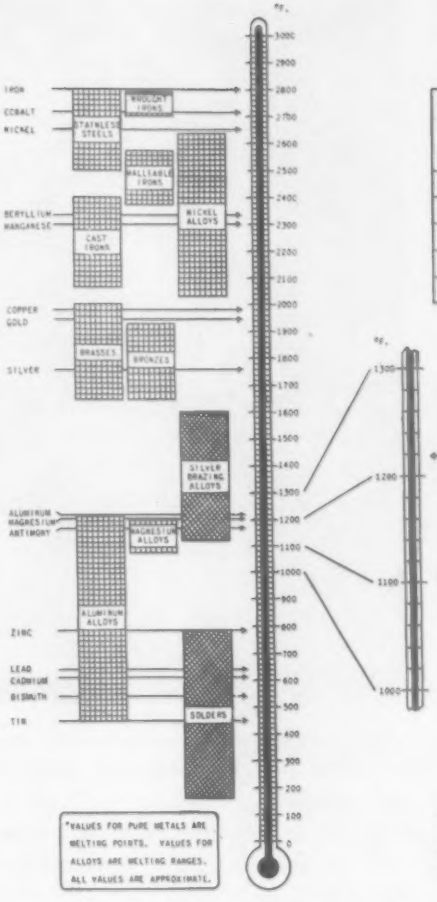
Typical properties associated with non-heat-treatable aluminums in the O and H tempers and with heat-treatable aluminums in the O and T tempers, respectively, are listed in Fig. 1. It will be noted that all values listed for the O temper, except for elongation (ductility), are lower than for the corresponding H or T temper of the same material.

Strength and Corrosion Resistance

The strength of brazed aluminum joints depends upon several factors including the composition of the particular aluminum joined, the type of joint involved, the extent to which the brazing is properly done, the postbrazing thermal treatments given, etc. In general, however, the strength of torch-brazed joints is about the same as that of torch-welded joints in material of the same composition and temper.

It should be realized that, except where the metal is already annealed (O temper), the brazing heat anneals it, at least at the joint area, and the amount of annealing is proportionate to the amount of heat and length of time it is applied. Also the extent to which the metal can be restrengthened depends on the extent to which the metal involved responds to postbrazing thermal treatments. For example, if the metal is one of the non-heat-treatable group (types 1 and 2), it can be restrengthened only slightly if at all; whereas, if it is one of the heat-treatable group (types 3 and 4), it can be solution heat-treated to bring it up to the W temper and subsequently aged to the T temper.

It is obviously uneconomical to use the more costly hard tempers if the material is to be left in the annealed condition after brazing or if postbrazing thermal treatments other than simple local quenchings are planned. Designs involving brazed joints should therefore take into account the possibility of employing postbrazing thermal treatments. When such treatments are either impossible or impracticable, the annealed material should be used, adjusting the calculated strength and other properties accordingly.



TYPE OF ALUMINUM	MELTING POINT OR MELTING RANGE °F.	BRAZING TEMPERATURE RANGE °F.	
		USING 020 FILLER METAL	USING 0716 FILLER METAL
PURE ALUMINUM	1218	1100–1185	1080–1090
25 ALLOY	1190 – 1215	1100–1185	1050–1090
35 ALLOY	1190 – 1210	1100–1185	1050–1090
535 (OR R353) ALLOY	1075 – 1205	–	1050–1090
615 (OR R361) ALLOY	1050 – 1205	–	1050–1090

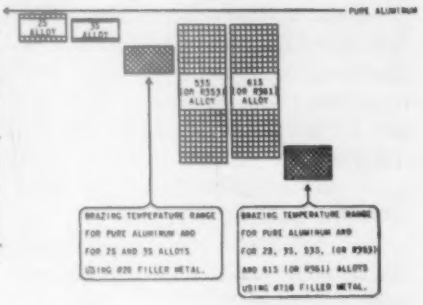

°F.
1300
1200
1100
1000
PURE ALUMINUM
25 ALLOY
35 ALLOY
535 (OR R353) ALLOY
615 (OR R361) ALLOY
BRAZING TEMPERATURE RANGE FOR PURE ALUMINUM AND FOR 25 AND 35 ALLOYS USING 020 FILLER METAL.
BRAZING TEMPERATURE RANGE FOR PURE ALUMINUM AND FOR 25, 35, 535, (OR R353) AND 615 (OR R361) ALLOYS USING 4716 FILLER METAL.

Fig. 2—Aluminum melting and brazing temperatures as compared to the melting temperatures of other metals

Filler Metals and Fluxes

Because of the exceptionally low melting point of aluminum, its characteristic quick-forming and tenacious oxide film, its susceptibility to electrolytic corrosion when brought into contact with certain other metals, etc., the use of filler metals and flux of special composition is required.

Filler metals suitable for brazing the types of aluminum discussed are listed in Figs. 1 and 2 and are designated for purposes of reference as No. 26 and No. 716, respectively. It will be noted that these filler metals are used as follows:

For brazing the aluminums which melt at higher temperatures (types 1 and 2, pure and the previously mentioned high-purity types), either No. 26 or No. 716 may be used. No. 26 may be preferred where greater chemical composition similarity of joint and joined metal is desirable as in vessels contacting food, pharmaceuticals, etc.

For brazing the aluminums which melt at lower temperatures (types 3 and 4), No. 716 is used.

Because these filler metals are themselves aluminum-base alloys, the susceptibility to corrosion caused by differences in electrolytic potential is lessened and the strength obtained is strictly comparable to that obtained in welding. Joints made with these filler metals are shown in Fig. 3.

For best results in brazing aluminum, the flux used should meet at

least the following six requirements:

(1) It should be easy to mix and to apply.

(2) It should melt and become active at a temperature below the required brazing temperature. However, the flux melting temperature should not be so low that it will lose its usefulness in serving as an indicator when the required brazing temperature is being approached.

(3) It should flow smoothly at the brazing temperature and spread out ahead of the molten filler metal.

(4) It should effectively shield the metal from oxides formed during the brazing operation and thus maintain the surfaces for easy flowing and bonding action by the filler metal.

(5) It should be easy to wash off after the brazing is completed.

(6) It should remain chemically stable during all the conditions normally encountered.

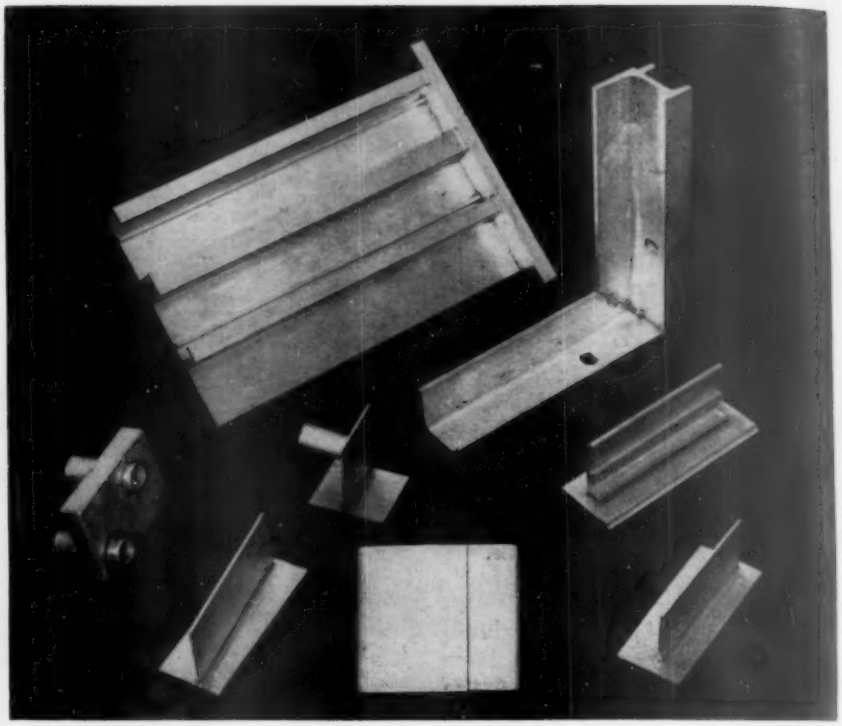


Fig. 3—Typical joints made with aluminum-base filler metals. In general, lap, fillet, lock seam and tee joints give best mechanical properties

The Brazing Flame

Commercially available gas combinations that might be considered for use in torch brazing aluminum include oxy-acetylene, oxy-hydrogen and the various oxy-natural-gas combinations. The oxy-acetylene combination produces a flame of a temperature estimated to be approximately 6,300 F. This is the highest temperature of any known flame.* The flame produced by the oxy-hydrogen combination is estimated to be approximately 2,000 F lower, and the temperatures produced by the various oxy-natural gas combinations are still lower.

Since very low brazing temperatures are required in brazing aluminum, the use of a high-temperature flame may, at first glance, appear undesirable. Actually, however, the oxy-acetylene flame, producing the highest temperature of all, is the one most generally preferred. Reasons for this preference are:

The high heat output makes it possible to bring the metal up to the required brazing temperature in less time, thus speeding up the brazing operation and consuming less gas.

The high heat output also makes it easier to concentrate the heat where it is wanted. Thus the operator can fix his attention on the brazing zone and does not need to watch other parts of the assembly which might tend to buckle or collapse if the greater heat spread of a flame less easy to concentrate were used.

A neutral or slightly reducing (non-oxidizing) flame is required in brazing aluminum. This type of flame is more easy to identify and to maintain when the oxy-acetylene process is used.

Joint Design

In general, optimum mechanical properties in brazed aluminum joints are obtained through the use of such joints as lap, fillet, lock seam and tee joints in preference to butt and scarf joints. (The latter, however, will be the only practical joints in some instances.) Joints of relatively thin cross-section (which is another way of saying thin deposits of filler metal) or small clearances between mating members also add to the strength, but complete penetration of the filler metal is probably the most important consideration.

Complete filler-metal penetration is sometimes aided, sometimes hindered by gravity. It is always favorably influenced by capillary forces, which exert a greater influence when clearances or distances between mating members are small than when they are large. When clearances are too small, however, other counteracting forces (surface tension, alloying, etc.) become effective and either retard or entirely stop the flow of filler metal. Consequently, clearances that are neither too large nor too small are necessary to secure complete filler-metal penetration.

The exact amount of clearance required depends upon the type of joint involved, the length of lap, relative thicknesses of mating members and other factors. As an example, it has been determined that for lap joints in average applications the approximate required clearances are from 0.006 to 0.010 in. for laps up to ¼ in. long and from above 0.010 to about 0.025 in. for laps ¼ in. or longer.

A common rule-of-thumb method

* A hotter flame may perhaps be produced by the newly developed hydrogen-fluorine torch. See "The Hydrogen-Fluorine Torch," page 42, The Welding Engineer, March, 1947.

to determine lap length for brazed lap joints is to use laps three times as long as the thickness of the thinnest member.

To assure consistent maintenance of the required clearances in production work, designs should provide for dimensional accuracy in the joined edges of mating members. Irregularities in this respect lead to poor fit-up in assembly, and this in turn produces brazing difficulties.

Holding Parts for Brazing

Insofar as possible, products should be designed so that the parts are self-jigging, or, at least, easy to position for the brazing operation. In some cases, what amounts to self-jigging can be accomplished by adding a flange to one of the mating members. Holes are then punched or drilled in this flange to register with holes in the other mating member, thus permitting the parts to be held together for brazing by pins, staples, etc.

Maintenance of the required clearances has in some instances been assured by crimping, corrugating or grooving one of the edges to be joined. The lands between the grooves can be set flush to the parallel edge of the mating member, and the grooves, if properly machined, are the exact depth needed to provide the proper clearance for the flow of the filler metal and the flux. This procedure involves machining but greatly simplifies set-up procedures and the designing of suitable jigs, fixtures and positioners.

Manufacture of lightweight metal furniture stands high among modern applications of aluminum torch brazing. This intricate Baroque table, 42 in. in diameter, is fabricated by the Elliott Mfg. Co.

Wherever possible, it is desirable to design each brazed joint so that it has a sort of a "back door" through which the flux may make its exit after completing its work. It is also desirable in closed assemblies to provide means for the escape of the gases generated during brazing.

The use of correctly designed jigs, fixtures and positioners pays substantial dividends in production operations. Such fixtures serve to maintain dimensional accuracy and assure uniformity in the finished product. They also permit the work to be done on an assembly-line basis. We have already seen how necessary it is in the brazing of aluminum to maintain specified clearances between mating members. The use of properly designed jigs, fixtures or positioners insures these clearances automatically.

In designing jigs and fixtures, it is essential to take into account three important characteristics of aluminum; namely, high heat conductivity, high coefficient of expansion and low melting point.

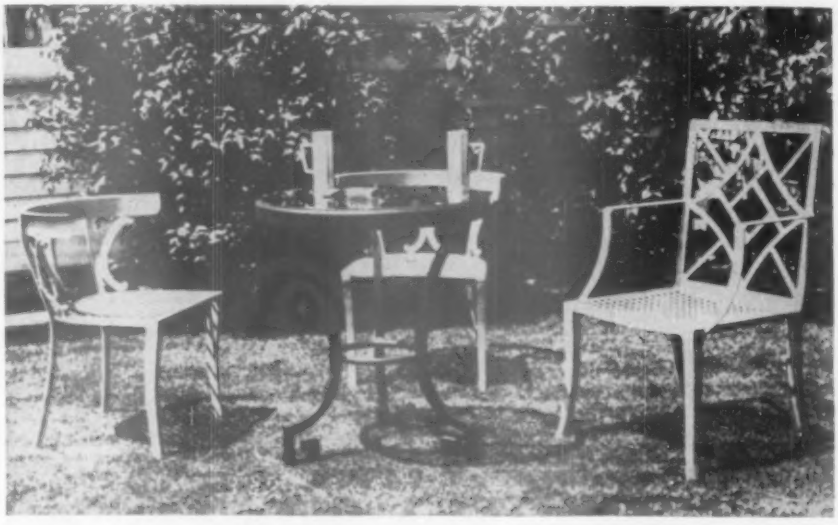
The high heat conductivity requires that jigs be designed so that they do not unnecessarily draw the heat away from the brazing zone. One method of meeting this requirement is to design for what is commonly referred to as "point" contact with the assembly.

The high coefficient of expansion makes it impracticable to use jigs, fixtures and positioners made of steel or cast iron. The resulting differences in expansion will tend to draw the parts out of alignment and thus cause distortion, cracking or altered clearances. Jigs for aluminum brazing should be made of aluminum or an alloy with a similar coefficient of expansion. (See Engineering Data Sheet No. 70, The Welding Engineer, July 1946, for comparisons.)

If jigs, fixtures and positioners are made of aluminum, the low melting point makes it necessary to take care. Obviously, fixtures must be made of an alloy which has a higher melting point than the required brazing temperature. They should also be shaped so that contact with molten filler metal and/or flux will be avoided.

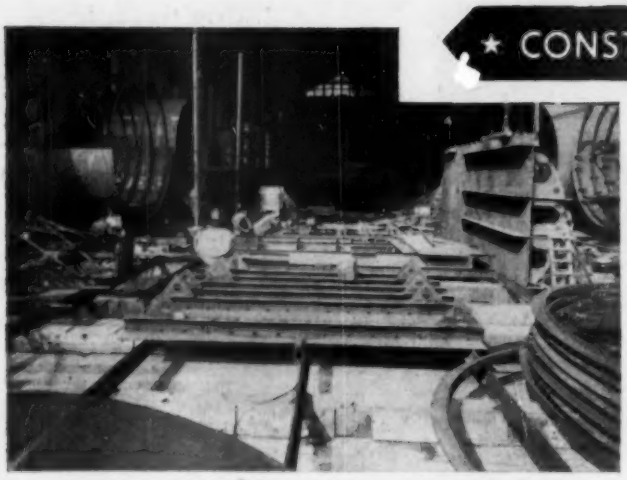
It will, in many cases, be profitable for those responsible for joint design and for the design of jigs, fixtures and positioners to collaborate or consult with one another in the development of such details as self-jigging, etc.

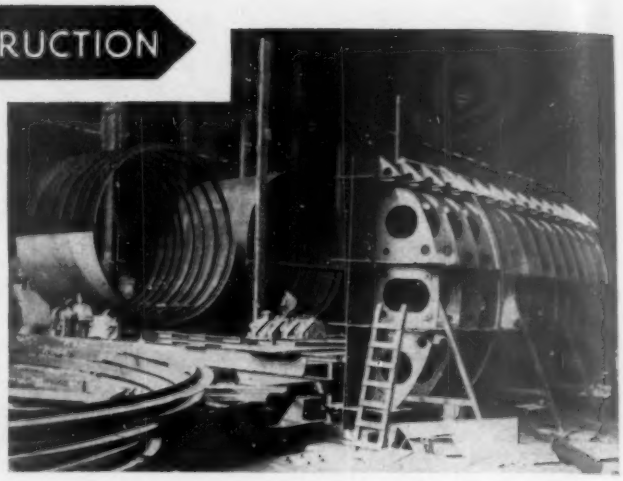
In the second installment of Mr. Huff's article he will discuss actual brazing procedures, covering the four steps of preparatory cleaning, fluxing, flowing the filler metal and postbraze cleaning.—The Editors.



Here are three more pieces fabricated by the Elliott Mfg. Co. by means of the aluminum-brazing technique Mr. Huff describes—a rounding chair, an arm chair of Chinese Chippendale design and a glass-topped Greek table

★ CONSTRUCTION





Welding British SUBMARINES

Fig. 1 (left)—Building slip for submarine construction, showing four sections on rollers (extreme left and right) and main engine seats (right). In the background is a submarine in a later stage of construction

Fig. 2 (right)—Another view of the building slip showing main engine seats and two sections on the rollers

Prefabricated methods of construction have proved highly successful for the building of submarines. The sections are rapidly assembled by automatic welding.

BY E. DACRE LACY

If and when submarines are ever powered with atomic energy, surface ships will be on their way out, say naval planners. For the use of atomic energy will convert the submarine into a true underwater vessel—one that is able to stay submerged as long as its commander pleases and travel at high speed for long distances while it is below the ocean's surface. If this contingency ever comes to pass—and who today is able to say that it will not?—then submarines will have to be used to transport troops and supplies, for to use any type of surface vessel for these purposes would be to court almost certain disaster.

During the last war, welding made it possible to turn out a large number of underwater craft in a short time. Very few of the details of their construction were ever released to the technical press. Because of the potential importance of the submarine to the world of the future, the author feels that a brief summary of the history of the application and development of welding to submarines built in British shipyards will be of interest to the welding industry of the United States.

Early Developments

Welding began to facilitate submarine construction as long ago as the period immediately after the 1914–18 war, when welded plate intercostals were fitted in lieu of angles to internal flats bounding compartments of test pressure below 50 psi. Previously, welding had been in use for some time for minor fittings—pipe flanges, ventilation trunking, etc.

The substitution of weld-fabricated structures for steel castings was the next step. A typical example is provided by the forward bulkhead casting. This bulkhead houses the lip ends of the bow torpedo tubes, cap-operating gear, etc., and its casting is necessarily intricate. During the building of the first "O" class submarine, several bulkhead castings had to be cast before a satisfactory one was obtained—in fact, two were actually erected before defects were revealed by the machining necessary for the torpedo tubes. It was therefore decided to experiment with welded structures on the next "O" class. The experiment was successful, and welding was adopted as a permanent feature of future design.

No special development in welding took place between 1926 and 1939. In the latter year, however, welded T-frames were fitted to the main hull in lieu of a standard riveted Z-frame.

By this time progressive shipbuilders had realized that welding should not be regarded as an alternative to riveting, but that the initial design should be made to incorporate welding, modifying the method of construction as much as necessary. In the meantime, X-ray

technique had been developed and applied to ship construction.

Germany was producing all-welded submarines, and this fact gave a great impulse to British welding. Hence it was decided to consider the construction of an all-welded submarine.

Arrangement of Sections

The pressure hull of a submarine lends itself admirably to prefabrication. A scheme was worked out during 1943 in the drafting room at Chatham dockyard to divide the submarine into a number of sections and to construct them in such a manner that the maximum amount of welding could be performed downhand. The constant section or parallel middle body was approximately 16 ft in diameter and 110 ft. long This was divided into nine sections of an average length of 12 ft, since this size of section was the best which could be conveniently handled by the slipway cranes. Each section consisted of two semicircular plates joined by welding. The seams between sections were staggered to avoid a four-way junction of welds.

The plating for the fore and after ends was divided into strakes, the plates used being shorter and narrower than had been employed for riveted submarines. This was to enable every plate to be developed upon the mold loft floor and the plates prepared well before they were required to be fitted. All plates were butt welded at the seams, using large electrodes. Careful edge preparation was given to insure the maximum amount of downhand welding. Corresponding butts and seams port and starboard were welded simultaneously whenever possible. Generally the butts were welded before the seams. The "stepback" method was used throughout.

For a later vessel, the pressure hull was redesigned to permit complete prefabrication. The constant section was built as described above, and the lines of the forward and after ends were slightly modified from the previous design in order to simplify the shape of the plates. This alteration, in effect, resulted in each plate becoming a portion of the surface of a frustrum of a cone and, as such, capable of being easily rolled to shape. The knuckling caused at the butts of the plates was so small as to be negligible. The sections in the fore and after ends averaged 9 ft in length in this particular ship. All plates were developed on the mold loft floor.

Slipway Layout

The building slip at Chatham is completely roofed and protected at each side and also enclosed at the lower end. For launching, a portion of the lower end can be hinged upwards. The slip is served by two 10-ton and one 15-ton travelling cranes. These limit the weight of the largest sections which can be handled. For the erection of sections a number of sets of rollers were constructed and installed. These can be seen in Fig. 1. Each unit consists of four rollers, two of which were rotated by a motor through reduction gearing. Thus a section could be placed on the rollers and rotated for welding. A special set of four rollers was used for building of the conical sections, two of the rollers being movable in a vertical direction to allow the upper face of the section to lie horizontally. A central a-c welder was laid out to supply 60 weldors at 300 amp and nine weldors at 600 amp or 39 weldors at 600 amp. Figs. 1 and 2 show sections on the blocks ready for welding.

Prefabrication

The method of prefabricating the sections was as follows:

(*a*) The large semicircular pressure-hull plates were planed, including edge preparation for welding, and rolled in the machine shop. They were then transported to the building slip on a special trailer.

(*b*) The bottom semicircular plate was placed on a set of four rollers.

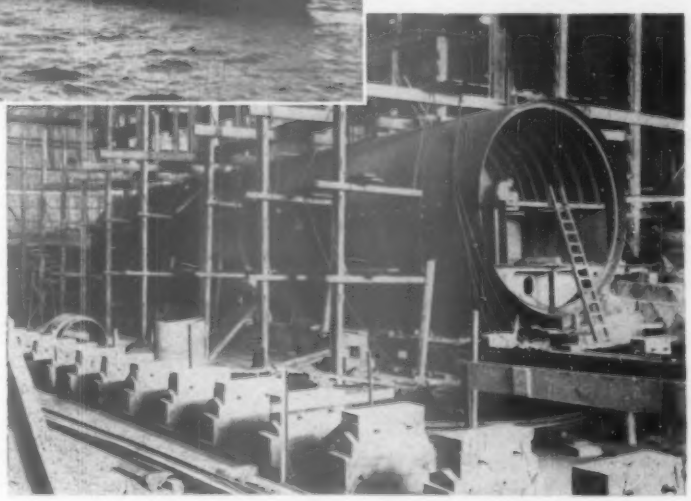
(*c*) T-bar frames, already turned and butt welded, were erected in the correct positions and clamped to the bottom plate.

(*d*) Top semicircular plates were correctly positioned and clamped to the frames and bottom plate.

(*e*) Back run of welding was applied manually to the seams, while the section was rotated to enable all welding to be done downhand. The seam closers were removed, and the frames were notched in way of the seams.

Fig. 4 (left)—The end product: an all-welded British submarine in the water

Fig. 3 (below)—Seven sections assembled on the blocks, five welded together



Photos courtesy British Information Services

(*f*) The section was turned to locate seams at the top and bottom. The top seam was welded by a submerged-melt head. The section was then turned through 180 deg, and the opposite seam was treated similarly. Finally the manual back run was gouged out and rewelded.

(*g*) The T-bar frames were tack-welded to the plating, and the closers were removed.

(*h*) The T-bar frames were now completely welded to the plating by the submerged-melt head. Minor difficulties were experienced in this operation; *e.g.*, application of the granulated flux, variation in face angle of fillet weld and weld porosity. Most of these difficulties were eventually overcome by mounting the welding head on a low gantry through the section, the head remaining stationary while the section revolved. Porosity was obviated by preheating the seam with a torch immediately prior to welding.

Fabrication of conical sections was performed on similar lines. Here, however, the section was stood on end to enable the frames to be manually welded downhand as the submerged-melt machine could not be employed.

Bulkheads were fabricated out of place and erected in one piece in the appropriate section, the boundary being welded to a hoop plate on the pressure hull. Other structures such as battery tanks, minor bulkheads, etc., were welded into sections as required; these were completed structurally as far as possible before they were fitted into the ship. Engine girders and bearers were fabricated in one piece and fitted on board. Each section upon completion was transported by an overhead crane to its correct position on the building blocks and closed to the correct welding gap and alignment by clamps. Fig. 3 shows seven sections on the block, five of them welded together.

The sections were butt welded by six weldors employed simultaneously on one butt. They used the step-back method with large electrodes and completed a weld in five passes.

Welding of the external hull developed along lines similar to that of the pressure hull. Here, again, orthodox shipbuilding has given way to prefabrication. With the advent of the welded frames to the pressure hull, brackets connecting framing of externals were welded to pad pieces, which were in turn welded to the pressure hull; thus a concentration of welds was avoided.

The superstructure was prefabricated in lengths of approximately 30 ft. Welded pad pieces were fitted on the pressure hull to take the connecting brackets as mentioned above for the external hull. Fig. 4 shows an all-welded submarine after launching.

The ballast keel formerly consisted of solid cast iron and elm blocks, together with two ballast boxes, one forward and one aft, made of plate and angles. Now the whole of the ballast keel is a fabricated structure and welded to the pressure-hull sections before they are assembled on the building blocks.

Weld-fabricated structures have replaced castings for such parts as stern-fin castings, shipbuilders' tubes, bull-ring and torpedo type bulkhead forward, etc.

Radiographic Inspection

X-ray photographs were taken at selected positions of welded joints in the pressure hull, and any defects found were made good. Every T-junction formed where the longitudinal seam met the butt was X-rayed, as well as many intermediate positions.

During the war the new construction undertaken at Devonport dockyard included the all-welded *Totem* and *Truncheon* of the "T" class. Owing to the limited lifting power of the derricks around the slip, prefabrication was not possible, and the two vessels had to be built plate by plate. The shell plates were all butt welded.

The welding facilities around the slip consisted of 50-volt d-c motor-generators and 100-volt a-c transformers with six 300-amp regulators to each. From time to time, radiographic examination of the welding was made in the positions where defects might be expected; *i.e.*, T-junctions and awkwardly situated butts. The making of this examination had the effect of improving the quality of the welding to a considerable degree.

The two submarines of the next class, *Ace* and *Achates*, were also all-welded; these were different in many ways from the "T" class. The keel included a tank which was built up from heavy plate, corner welded in the shop and erected in one piece. The method of construction of these two submarines was determined by the lifting power available. In general, however, it did not differ materially from that of the *Totem* and *Truncheon*.

Repair Work

Because of their excellent welding facilities, the same yards that built submarines were also called upon to repair battle-damaged cruisers, escort vessels, minesweepers and other craft.

Space does not permit description of the many interesting repair jobs which were done wholly or mainly by welding at the Royal dockyards, but one of the most noteworthy was the repair of an escort vessel damaged in collision about D-day. The damage was on the port side and extended down to the bilge and inwards to the funnel casting. The damaged structure was cut out, and new plating and framing were welded into place. The job was completed in five days. Though these repairs were intended to be temporary, they were never replaced.

The building up by welding of fittings normally made as steel castings was often found to be absolutely necessary, as replacements could not be obtained in time to avoid loss of the vessel for a long period. In one case an escort vessel arrived with her stern blown off. Not all the castings were available from reserves, and the spectacle castings, rudder-head castings and some portions of the steering gear were built up by welding in a fraction of the time necessary to make patterns and obtain new castings.

(*Continued on page 66*)

Can you answer these questions about WELDING CAST IRON?

A TWO-MINUTE QUIZ OF INTEREST TO EVERY WELDER

Q. Is it harder to weld cast iron than steel or other metals?

A. Cast iron frequently proves more difficult to weld than other common metals. This is because of cast iron's tendency to change its structure under high heat.

Q. What is the effect of welding heat on cast iron?

A. Some of cast iron's useful properties depend on a proper balance between graphitic and combined carbon. When cast iron is reheated to the molten state, as in welding, some of the graphitic carbon recombines with iron to form combined carbon. Unless the iron cools gradually, the carbides thus formed remain as combined carbon. An excessive amount of combined carbon in cast iron makes the iron hard and extremely difficult to machine.

Q. How can this tendency be eliminated?

A. First, by avoiding excessive heat in the welding zone. Second, by obtaining a slow rate of cooling. Third, by choosing the right welding material.

Q. What is the best method of welding cast iron?

A. All have their advantages. For years, oxy-acetylene was the favorite. Now, however, because of recent improvements in electrode composition, the metal-arc method is coming rapidly to the fore.

Q. What are these improvements in electrode composition?

A. Research on electrodes for welding cast iron has centered around achieving strong, machinable welds, free from cracks and porosity. At INCO this has meant the careful study of the materials used for core wire and flux coatings in the development of the NI-ROD* electrode.

Q. Does NI-ROD provide sound, strong, welds?

A. Extensive use has proved the soundness of NI-ROD welds. NI-ROD's slag does an excellent job of scavenging gas from the weld metal, assuring deposits of maximum strength and freedom from porosity.

Q. Is preheating necessary with NI-ROD?

A. NI-ROD flows so well and "washes" so evenly against the sides of the joint that it is usually unnecessary to preheat the joint. However, hard-and-fast rules cannot be formulated to cover all conditions. Preheating to 300-400°F is useful on many jobs to reduce stresses or provide the highest degree of machinability.

Q. Are NI-ROD welds easily machinable?

A. Yes, NI-ROD's deposit and weld zone are easily machinable. The deposit is nickel, a metal which doesn't lose its machining characteristics under rapid temperature changes. The fusion zone retains its machinability because NI-ROD's smooth arcing and flow characteristics keep the heating-quenching cycle to a minimum.

NI-ROD comes in $\frac{3}{32}$", $\frac{1}{8}$", $\frac{5}{32}$" and $\frac{3}{16}$" diameters. Order a 5-lb. package and you'll agree it's the ideal answer to any cast iron welding problem where strong, sound, machinable joints are required.

*Reg. U. S. Pat. Off.

INCO NI-ROD TRADE MARK

Be sure to ask for your copy of the NI-ROD instruction booklet.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

NI-ROD *is distributed by:*

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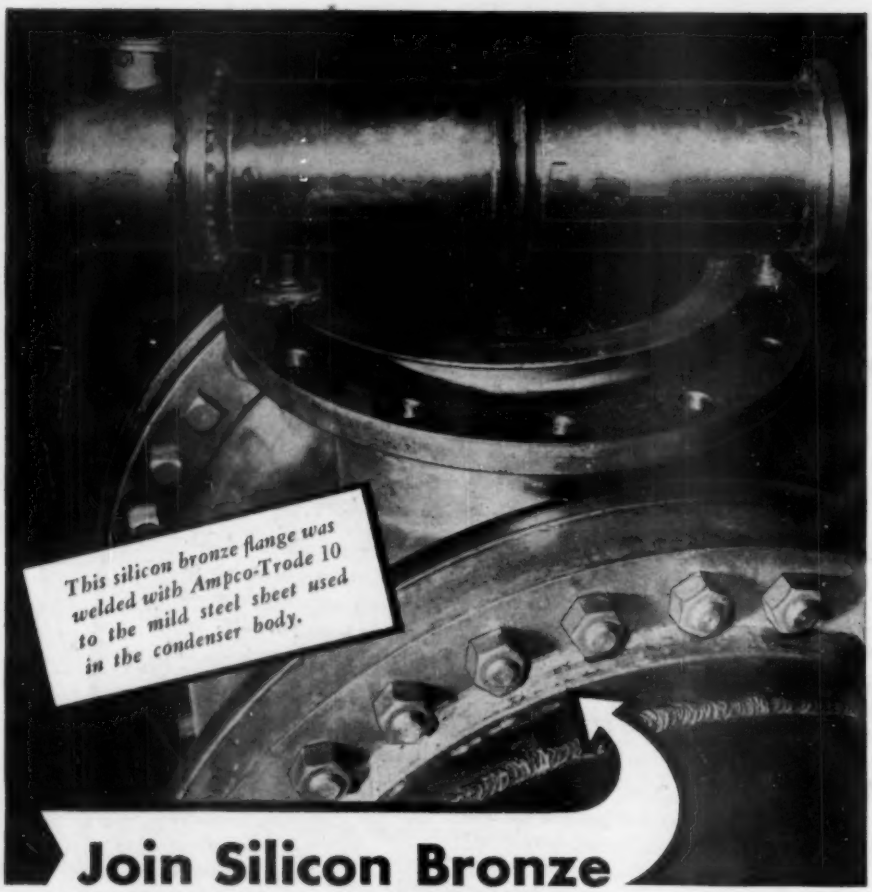

Join Silicon Bronze to Mild Steel Easily . . .

You can join dissimilar metals with

AMPCO-TRODE 10
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COATED ALUMINUM BRONZE ELECTRODES

When confronted with the problem of welding silicon bronze to mild steel, you can solve it with Ampco-Trode 10. Practical experience proves its superiority.

Ampco-Trode 10 is also preferred for welding many other types of dissimilar metals. With this useful electrode, you can join steel to clean cast iron; steel or cast iron to bronze, brass, and copper; and all these to nickel alloys.

And in addition, this all-purpose aluminum bronze electrode has other service possibilities. It is used for bearing applications and overlays where its hardness and resistance to wear are essential factors. Its corrosion-resistant qualities make it extremely important in process industry applications.

Ask for further information regarding Ampco-Trode 10. Consult us or our nearest distributor.

AMPCO METAL, INC. is the only manufacturer of a complete line of bronze electrodes for both arc and resistance welding.

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Department WE-5, Milwaukee 4, Wisconsin

W-98

WELDING SUBMARINES

(*Continued from page 64*)

One day a minesweeper came in with a broken main sprocket wheel in her sweeping winch. This cast-iron wheel, 3 ft, 6 in. in diameter, had been broken into five pieces. The pieces were reassembled, so that the exact diameter and spacing of the teeth could be determined. A new wheel was then fabricated by welding a forged rim and boss to a 2-in. web plate. The teeth were cut in the new rim, and the winch was reassembled. The whole job was completed within a fraction of the time that would have been required to make a pattern and obtain the casting or to obtain a spare wheel from America. A second vessel of the same class was similarly repaired later.

Repairs to large structural castings were often carried out in much less time than would be necessary to obtain new castings. In one case a rudder frame for a destroyer was broken through just below the head. This involved welding a very large square section of material. The pieces were brought together and veed out, extreme care being necessary as the break was not straight in any direction. Welding was carried out continuously with preheat, the rudder being turned over between alternate runs on each side. There was no distortion.

A shaft bracket forging which had been broken and removed from the ship was sent to the yard for repair. As the position of the break did not permit of a muffle being built for postweld heat treatment to remove internal stresses, the repaired casting was sent to the makers for heat treatment and checking. It was found to need slight correction, both in the welded arm and in the one which had not been affected.

At the Devonport yard, two former Cunard liners, *Aurania* (now *Artifex*) and *Alaunia* were fitted out as mobile workshops. About thirty weldors were employed for many months on this job.

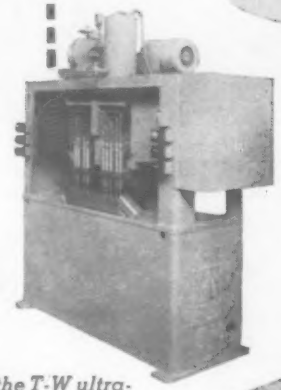
A cruiser which had suffered very heavy mine damage was repaired at the same yard, the job taking well over two years.

HOT PRODUCTION ON A -COLD ITEM-

★12 assemblies Every minute

(16 PIECES PER ASSEMBLY)

(Upper left) the welded, aluminum, flexible ice cube separator and the backbone strip before welding. Notice the 18 projections.



(Right) the T-W ultra-hydrospeed welder.

★ON A T-W HYDRO-ULTRASPEED WELDER

A jig holds the 16 aluminum parts (backbone, 7 fins and 8 inter-locking sections), and indexes into the T-W ultra-hydrospeed welder (illustrated). The 18 projections are automatically welded.

Four operators, working in pairs, produce 12 uniform assemblies per minute, every minute, hour after hour, with essentially no rejects.

Servel made use of T-W's Engineering Service and both collaborated to produce this superior design of welder for Servel's refrigerator tray ice cube separator.

Resistance welding, properly applied, can bring you new production returns, too. T-W representatives can assist you in adapting spot, projection, seam, or flash-butt welding to your products.

THE TAYLOR-WINFIELD CORPORATION
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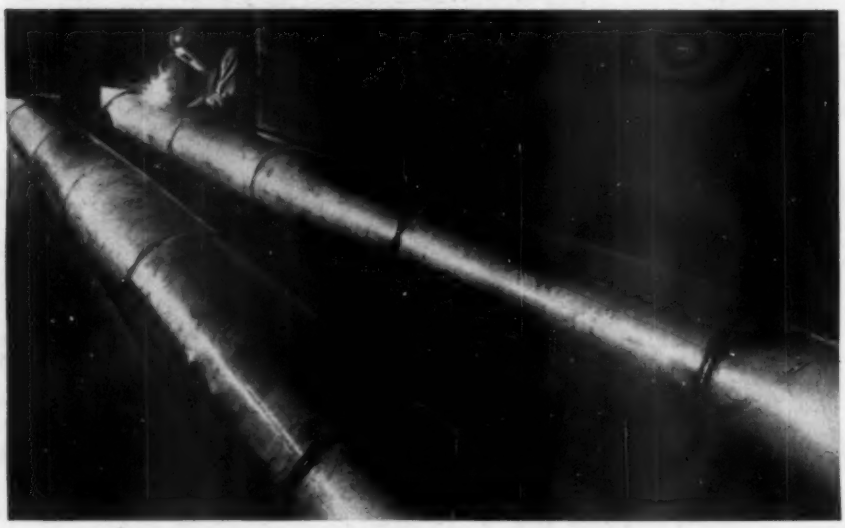
RESISTANCE WELDERS

On the Job

Stainless Exhaust Stacks

TWIN 80-ft exhaust stacks of 18-8 stainless-steel sheet were designed and fabricated for a dye works in order to dissipate acid fumes. Stainless proved ideal for this job because of its excellent corrosion-resisting qualities.

The stacks were constructed by first rolling the sheets and welding them longitudinally. The rolled sheets were then welded circumferentially into sections, using 19-9 stainless-steel electrodes.



Courtesy Air Reduction Sales Co.

Fabricated of stainless-steel sheet, these smoke stacks will go into service at a dye works

* *

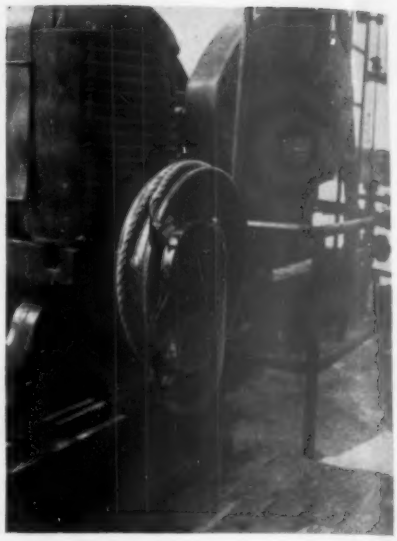
Welded Aluminum Molding

THE ALUMINUM molding shown in the accompanying picture was tack welded on the underside all the way around the top and bottom. The tacks were spaced six to eight inches apart. No warpage occurred, nor was the polished surface marred by the heat of welding.

* *

Underwater Testing Unit

A 223-ton welded pressure vessel to be used in testing underwater equipment is now being manufactured by The Babcock & Wilcox Co., Barberton, O., for installation at the new naval ordnance laboratory at White Oak, Md. The vessel is a cylindrical drum, 30 ft long by 100-in. ID, built of steel plate $3\frac{15}{16}$ in. thick. The door will close against a large ring that will be welded to the outside of the cylinder. Working pressure inside the drum is to be set at 1,000 psi, against which the door must be able to seal. All of the welded seams will be inspected by million-volt X-ray equipment, and the vessel will be stress relieved according to ASME code.



An old auto wheel welded to a shaft gives quicker and easier starting of farm and industrial engines in cold winter weather

Welded Engine Starter

By Elton Sterrett

TO FACILITATE engine starting in cold weather, one oil-field contractor found it advantageous to replace the hand crank with the type of starting system used for outboard motors. First, a salvaged automobile wheel was welded to the end of a stub shaft. A strip of steel was welded in as a filler on the drop-center rim, and a notch to engage the rope was cut in the edge of the rim. The first turns are given the engine by hand, but if it is unusually hard to turn over, the end of the rope can be tied to a car bumper and the car driven away in line with the wheel rim. This spins even the most stubbornly cold engine.

Courtesy All-State Welding Alloys Co., Inc.

The aluminum molding at the top of the picture was tack welded in place without injury to the polished surface. A low-temperature sheet-aluminum brazing rod was used

Fabricating Composite Tools

WHEN cleaning is done on concrete or steel floors where an explosive or inflammable medium is present, good practice dictates the use of beryllium-copper tools to minimize sparking. These safety tools are also non-magnetic and they can be heat treated to produce and hold the desired hardness on the cutting edge.

The floor scraper tools pictured herewith were ordered by one customer to be made from shanks of chrome-vanadium tool steel welded to beryllium-copper cutting heads. Sparking was not a hazard in the intended use, but the qualities of the beryllium-copper heads were desired.

The shanks were formed from stand-

Courtesy Ampco Metal, Inc.

Welded floor scrapers with beryllium-copper heads and tool-steel shanks

ard ½ by ½ in. bars of tool steel. The heads were prepared by veeing them to a 45-deg angle, forming a 90-deg included angle for butt welding. The carbon-arc process at a setting of 30 volts, 135 amp, was used with an aluminum-bronze electrode employed as a filler rod to join these two highly dissimilar metals (chrome-vanadium tool steel and beryllium-copper). As welding progressed, the copper cutting heads were occasionally submerged in cold water to avoid overheating and drawing of the previously hardened cutting edges. Strong welded joints capable of withstanding hard usage were produced.

Carbon-arc welding with a coated aluminum-bronze electrode is said to offer many advantages for certain applications such as better control of the filler metal and better heat concentration at the weld. Sound, homogeneous bronze deposits are obtained as bronze, unlike the ferrous metals, does not pick up carbon from the arc.

Use This Powerful GRINDER 3 WAYS

To Save Time On Many Welding Jobs!

Van Dorn Portable Electric Grinders can shave hours off your welding jobs . . . and save money and muscle, too! 1. They prepare surfaces for welding by "V-ing out," removing rust, scale, oxidation, old paint. 2. They smooth welds by removing excess metal. 3. They clean and buff surfaces for finishing.

Ask your nearby Van Dorn Distributor for full information on these time-saving tools. Send for our free catalog for details on Portable Electric Grinders and many other Portable Electric Tools for metal working. Address: The Van Dorn Electric Tool Co., 734 Joppa Road, Towson 4, Maryland.

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Van Dorn "Whirlwind"* Wire Brushes have each tuft locked in to stay! That means they're tougher, denser, last longer. Six wheel sizes: 4″ to 12″. Three wire sizes. Three wheel thicknesses.

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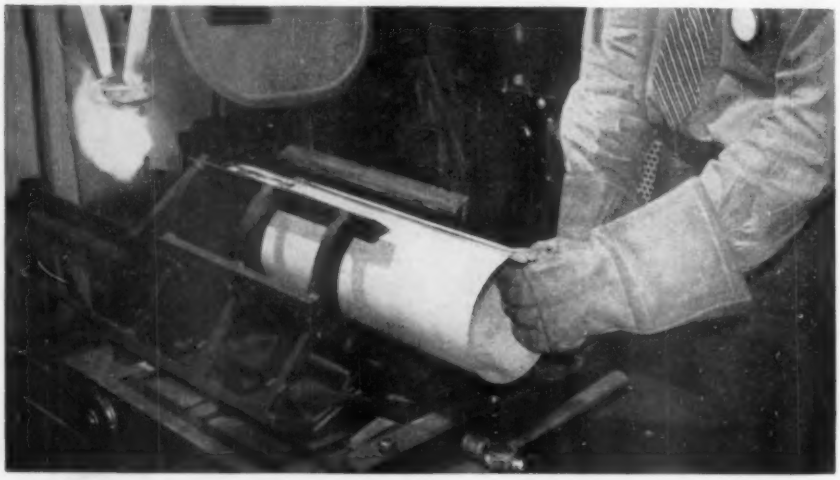
PORTABLE ELECTRIC TOOLS

Short Cuts and Kinks

Conveyor for A-H Welding

By William P. Brotherton

AN AUTOMATIC conveyor which speeds the atomic-hydrogen welding of stainless-steel sections has been designed and built by the Ryan Aeronautical Co., San Diego, Calif., for use in the manufacture of high-temperature exhaust systems for aircraft.



Ryan-designed automatic conveyor for use with the atomic-hydrogen welding torch. The stainless-steel section in the cradle is part of an aircraft engine's exhaust system

Welding time is critical in this fabrication because carbon precipitates out of stainless steel at temperatures of from 800 to 1,500 F and may form harmful chromium carbides to make a path for intergranular corrosion. In order to leave the steel formula unaffected, it is important that the welding heat should be confined to minimum time.

Using the new automatic conveyor, Ryan weldors have been able to step up the seam welding of exhaust manifold sections by the atomic-hydrogen process to 28 in. per minute. Smooth, strong welds are obtained, and the parent metal retains its original constituency.

* *

Shortening Eyebars

EYEBARS are metal bars with a hole for a pin or bolt at one or both ends. They are used in truss bridges. In many old pin-connected truss bridges, the pins and pinholes have been subjected to a high rate of wear resulting from the vibration of heavy locomotives.

Various methods have been used in the past in an effort to tighten eyebars loosened through wear. These were studied by a committee of the Welding Research Council, a project of the Engineering Foundation. In a preliminary report recently made public by Dr. A. B. Kinzel, chairman of the board of the Engineering Foundation, it was asserted that the fatigue and static strength of the bars was not appreciably affected by heating them with an oxy-acetylene torch in order to shorten them. The report said in part:

"The method which appears to be the most practical for tightening loose eyebars is to heat a small section of the bar to cherry red and then upset this heated part by special clamps and clamp bolts. This method was first used on American railroad bridges in 1916, with an especially built charcoal furnace that enclosed the eyebar to be shortened. The furnace was cumbersome, and it required a long time to heat the bars.

"During the past few years, several railroads have used oxy-acetylene torches instead of the charcoal furnace to heat the required area of the eyebar. The use of these torches has not only reduced the time required to heat the eyebar to the desired temperature but also insures a more uniform temperature of the heated area. . . Costly train delays are eliminated as only one hour is required to complete the work on one bar."

It is estimated by the Association of American Railroads that if this method were used to tighten all loose eyebars, the resulting saving would amount to about a million dollars a year.

Pipe-Cutting Attachment

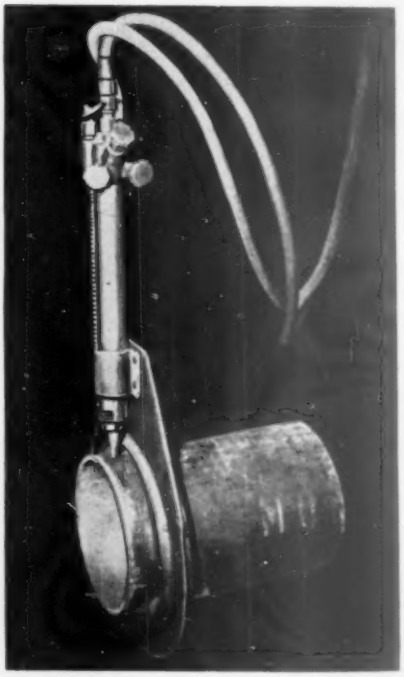
TO MAKE a good square cut on pipe by ordinary methods, the operator is required to follow the line of cut around the pipe, maintain the proper speed and keep the tip at the correct distance from the work. With the device pictured here, he has only to control the speed. This easily made attachment guides the torch in a true line and holds the tip at a constant distance from the work.

The base of the guide is a pipe flange, which is placed on the pipe to be cut as shown in the illustration. The flange stays in position while the rest of the attachment is rotated around it. Hence it should not fit too loosely over the pipe. If it is too loose, steel shims can be welded to the inside at three equidistant points. A boss is welded to the flange and fitted with a setscrew to prevent the latter from slipping on the pipe.

The rotating part of the guide is a collar cut from a piece of sheet steel; this should fit so that it can be revolved around the flange without binding and yet not be loose enough to wobble. Pins are welded to the flange to prevent the collar from coming off.

The torch holder is made by simply bending a scrap of sheet metal around the torch like a clamp and bolting it to the wide part of the collar. The guide can easily be adapted to practically any torch by changing the design and size of the holder.

A device of this kind works best when used on only one diameter of pipe. It should find particular use in the small shop that has frequent occasion to cut pipe of one specific size or that has a quantity of cuts to make all at once.



Courtesy The Linde Air Products Co.

This pipe-cutting attachment was easily made from a discarded pipe flange and a rotatable collar cut from sheet steel scrap

These aluminum pressure-tight drums are welded four at a time on an automatic carbon-arc welding machine. The aluminum is $\frac{3}{16}$" Alcoa 3S, and Alcoa No. 24 welding flux is used.

All types of welds can be made commercially on aluminum. Standard welding equipment and techniques are used with minor adjustments of flames or machine settings.

The 120-page booklet, "Welding and Brazing Alcoa Aluminum" will be sent to you on request. And our staff of welding specialists will be glad to help you with any welding problems that the booklet doesn't clear up. ALUMINUM COMPANY OF AMERICA, 1751 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in leading cities.

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News of the Industry

Chicago Production Show Gives Welding Course

SOME 25,000 engineering technicians attended the 35 panel sessions of the Chicago Production Show and conference, held March 17 to 19 at the Stevens Hotel. In connection with the three-day conference some 120 exhibitors displayed their products and equipment. Among the many members of the Chicago chapter of the American Welding Society who helped to make the event a success were Leslie S. McPhee, welding supervisor, Whiting Corp., and Leslie U. Burgess also of the Whiting Corp. Mr. McPhee served as chairman and Mr. Burgess as a member of the shows General Committee.

In accordance with a prearranged policy of "talking down" for the benefit of those unfamiliar with welding, two panel sessions were sponsored by the Chicago chapter of AWS. These were designed to give an elementary course in the subject. The first welding session was held on Monday morning, March 17, under the chairmanship of Leslie S. McPhee. The "professor" for the occasion was T. B. Jefferson, editor of THE WELDING ENGINEER, who covered the fundamentals of every phase of welding. Questions from the floor were answered by the speaker and his panel of experts, consisting of C. L. Pfeiffer, welding engineer, Western Electric Co., F. McGuire, Jr., service engineer, Linde Air Products Co., W. C. Pearson, welding engineer, Westinghouse Electric Corp., and L. G. Pickhaver, welding engineer, General Electric Co. The second welding session, held Tuesday afternoon was devoted to the subject of metallurgy and testing of welds. A talk on this subject was delivered by Eric R. Seabloom, supervising engineer and head of research department, Crane Co. This was followed by questions from the floor which were answered by Mr. Seabloom and I. H. Carlson, research engineer from Crane Co.

* *

LeTourneau Forms "Tournalayer" Division

R. G. LETOURNEAU, INC., Peoria, has opened a new division at Longview, Tex., to handle sales of the "Tournalayer"; a unique construction machine which molds a concrete framework for a four-room house in 24 hours. Both production and sales will be handled in Longview under the direction of Richard L. LeTourneau, division manager.

The first Tournalayer to be sold on the export market was recently shipped to Brazil to be used on a giant homebuilding project at Sao Paulo.

All-Welded Dredger Launched in Scotland

THE FIRST all-welded dredger in Scotland was launched recently on the Clyde river by the shipbuilding firm of Lobnitz and Co., Ltd. Built for the French Government, the 600-ton *Mediteranee* is a non-propelled bucket dredger with an estimated dredging capacity of 800 tons per hour. Her 28-cu-ft buckets are capable of dredging a depth of 60 ft.

The *Mediteranee* is one of three sister ships, the remaining two of which are also under construction at the Scotch shipyard. She represents the second all-welded vessel to be built by the Clyde river firm, which began to plan ten years ago the special layout and organization that is needed for welded ship construction. Contrary to the usual practice at British shipyards, this firm has no riveters at all on its staff of 800 employees.

Another Scotch firm using welding to a great extent is John Brown and Co., Ltd. This company is constructing an all-welded destroyer to the order of the Admiralty to test the efficiency of welding for the severe conditions under which destroyers operate.

* *

Reid-Avery Buys Welding Rod Plant

REID-AVERY CO., INC., has purchased from the War Assets Administration a surplus Government plant located in Dundalk (Baltimore) Maryland. The two-story building contains 45,000 sq ft of working space and the following equipment: two vertical presses, one mixing machine, one flash rod breaker, one Day Re-Ball screen, two jet units, one disc grinder, four draw blocks, one wire pointer, two block strippers, seven cutting machines, two stripping machines, two forming presses, ten welding electrode oven tunnels and heaters, etc. The plant cost the Government $436,531 and was sold for $277,000 in cash.

The new owner expects to add 40 workers for the commercial production of wire welding rods and electrodes.

Develop New Device for Measuring Metal Grains

A GRAIN size "comparator" that almost counts the number of grains in a photomicrograph, has been developed by F. C. Hull, of Westinghouse research laboratories.

To determine the grain size of a particular specimen, a polished and etched sample is placed on the stage of a standard metallograph and projected in magnified form on the glass screen. Its granular boundaries can be seen in maplike form. A transparent slide of a known, standard grain structure is slipped into the wooden frame and illuminated by incandescent light. The magnifying power of the metallograph is then changed by extending the bellows until the unknown image matches the grain size of the standard. The amount of adjustment needed determines the grain size of the unknown specimen.

* *

Arc Welding Builds up Locomotive Wheel Centers

LOCOMOTIVE wheel centers battered by years of service can be restored to their original diameters by arc welding so that standard tires can be fitted to them, it is reported by M. J. Conway, electric welding division of the General Electric Co.

Several arc welding methods have been used successfully. Some wheel centers have been built up with deposits made by manual welding with bare or lightly-coated electrodes. Some have had steel bands welded to them in order to bring them up to the original diameter. The most economical way, however, according to Mr. Conway, is by machine welding, using automatic heads that feed bare or lightly-coated electrodes.

* *

Hidden Pipes Melt Snow at Pittsburgh Bus Terminal

SIDEWALKS of the new Union Bus Terminal, now nearing completion in Pittsburgh, will be as dry in mid-winter as any sidewalk is on a sunny July afternoon. This is due to the terminals novel snow-melting system, which consists of wrought-iron pipe coils embedded in the concrete walk. Steam circulating through welded piping will keep the pavement temperature above freezing and assure a safe, dry footing for pedestrian traffic.

Handy & Harman's new West Coast Service plant at 3625 Medford St., Los Angeles

Courtesy, The International Nickel Co., Inc.

Permanent repair to the cast-iron base of this street lamp was made for $12.50. A new base would have cost $45

Cast-Iron Lamp Posts Repaired by Welding

FREQUENT targets of careless drivers and accidental mishaps, the thousands of lamp posts in the City of New York have constituted a severe financial headache for the city fathers. Casualty rates among the cast-iron bases have been high, and replacements have averaged about $45 each. Obviously, it would be wise to repair the broken bases by welding—provided that some way to weld "difficult" cast iron could be found.

The Welsbach Street Lighting Corp., one of the maintenance contractors for the city, began experiments early this year to see if permanent welded repairs could be made on the 450-lb castings. The accompanying picture shows one of the welded lamp bases.

The first base thus mended had been girdled by a break which extended entirely around its girth. In making the repairs, the weldors used a new nickel-base electrode designed for making machinable welds in cast iron. Electrodes of $\frac{5}{32}$-in. diameter were used throughout.

Alignment was secured with a block and tackle. The upper half was suspended above the lower half so that the edges of the break fitted neatly together. The broken pieces were then tacked by four small beads applied at 90-deg intervals around the circumference. The finish seam was then made by a skip-welding procedure that kept the stresses equal. Beads about $1\frac{1}{2}$ in. long were laid intermittently.

* *

Titan Moves Tulsa Offices

TULSA, Oklahoma, offices of the Titan Metal Manufacturing Co., Bellefonte, Pa., have been moved from 310 Thompson Bldg., to 1348 S. Indianapolis St., Tulsa 4.

A *Convincing* TEST THAT YOU YOURSELF CAN MAKE

THESE "BRONZE BUTTONS" Prove the *Superior* STRENGTH of TITAN BRONZE WELDS

The above series of spot welds were made on greasy cast iron using TITAN Manganese Bronze welding rod. The test piece was chucked in a vise and the bronze spot welds knocked off with a hammer. In every instance the cast iron failed rather than the bronze weld.

This test is so simple you can duplicate it in your own shop . . . yet it proves conclusively that TITAN bronze welds are actually stronger than cast iron. That is why TITAN bronze welding rods are used so frequently for repairing cast iron parts, as well as steel, wrought iron, malleable iron, etc.

Titan Manganese Bronze has the following advantages:

1. *Uniform and easy flowing qualities.*
2. *Low melting point.*
3. *Good bonding properties.*
4. *Low fuming—A comfortable atmosphere for the welder.*
5. *Good machinability of the deposited Bronze Alloy in the weld.*
6. *Doubly Deoxidized (patented process) to produce:*
   - *A. Ductile welds.*
   - *B. High strength welds.*
   - *C. Dense, Non-porous welds.*
7. *Corrosion resistance.*

TITAN *Metal* MANUFACTURING CO.

GENERAL OFFICES AND PLANTS
BELLEFONTE, PA.

OFFICES AND AGENCIES

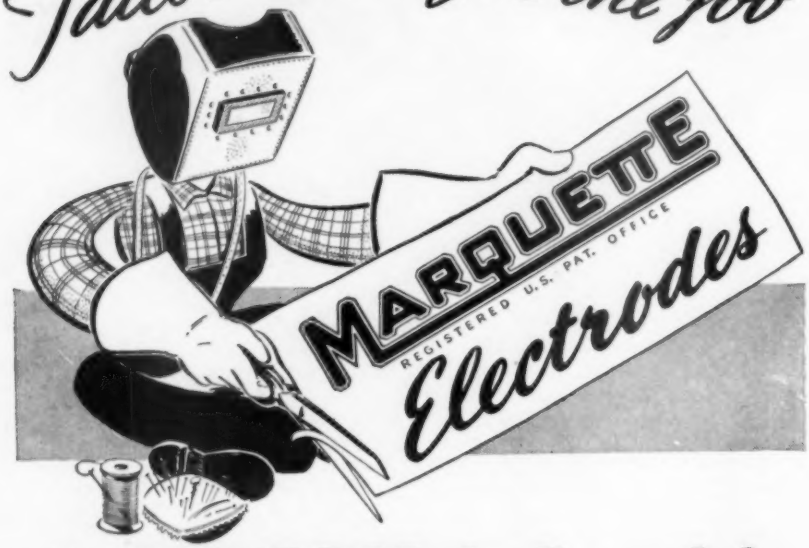
NEW YORK · CHICAGO · SAN FRANCISCO
DETROIT · CLEVELAND · CINCINNATI
ST. LOUIS · TULSA · DENVER
SALT LAKE CITY · ATLANTA · NEW ORLEANS

EXPORT OFFICE: 70 PINE ST., NEW YORK 5, N. Y.

Quality Alloys by Brass Specialists

Brass and Bronze Rod · Forgings · Die Castings · Welding Rods

Tailor-made for the job



the RIGHT ROD for Every Job

Tailoring Rods to meet the needs of industry . . . Marquette Metallurgists are creating new, outstanding Electrodes . . . each one a leader in the field. There is a Marquette Electrode for every welding job that will give you a stronger finished product at lower cost.

NICOL-ROD 44 . . . the Original and Best Nickel Rod. This copper-nickel alloy has a special coating which gives excellent welding characteristics. Makes perfect bond to parent metal with soft, close grained and thoroughly Machineable welds (without preheating). Marquette A.C.-D.C. NICOL-ROD 44 is low in cost but worth its weight in gold! . . . for years it has been used to salvage expensive foundry castings and on a multitude of maintenance jobs.

BRONZE-ROD 61 . . . a New development in electric welding pioneered by Marquette Metallurgists. It makes possible brazing of steel, cast iron and malleable castings, galvanized iron, bronze and other copper alloys by arc welding. This versatile Marquette A.C.-D.C. Electrode has good ductility and high tensile strength.

TOOL-ROD 650 . . . the scientifically balanced alloy of tungsten, cobalt and carbon steel produces a weld with *extra tough* cutting hardness. Unexcelled for renewing shear edges, lathe tools, drills, punches, dies, stone drills, auger bits etc. Build new tools and dies with low carbon steel and hard-surface the working edges with Marquette A.C.-D.C. TOOL-ROD 650.

BUY THE ROD-PAK or BUY THE CARLOAD

MARQUETTE WELD-ALL KIT

Your Maintenance department can take full advantage of Marquette's "Know How" which produced these outstanding electrodes by ordering the handy new 5 and 10 pound Marquette ROD-PAK, which comes in 17 TYPES and All Sizes of electrodes. Marquette Weld-All Kit gives you a generous supply of 12 types of various sizes in one handy package.

Order Marquette Electrodes in standard containers for your production Line. Special Discounts on single orders over 250 pounds.

THE NEW MARQUETTE ROD-PAK . . . in Handy 5 and 10 pound packages.

Sold Exclusively thru the Nation's Leading Distributors

MARQUETTE
REGISTERED U.S. PAT. OFFICE
Welding
EQUIPMENT

MARQUETTE MFG. CO. INC.
MINNEAPOLIS 14, MINN.

A.C. ARC WELDERS · ELECTRODES
GAS WELDING and CUTTING EQUIPMENT
ACETYLENE GENERATORS · ACCESSORIES

Russians Develop New Arc Welding Method

THEORETICAL research in the Russian laboratory of Academician V. P. Nikitin has resulted in finding a new method of arc welding said to revolutionize the entire welding process. This method is claimed to increase the speed of welding from five to ten times as compared with the most advanced methods used at present in the U.S.S.R. It renders possible the welding of 500 to 650 ft an hour under laboratory conditions and reduces the expenditure of power.

The new welding procedure is divided into two independently controlled phases: fusion of the parts being welded and fusion of the filler metal—in Russia known as the "addings."

According to Russian laboratory research, the cause for all difficulties and defects in ordinary welding is that the fusion of the parts being welded takes place simultaneously with the fusion of the addings. Most of the energy of the arc, say Russian scientists, is utilized for the fusing of the parts with the result that heat is lacking for the fusing of the addings.

To test the theoretical deductions, a 3,000-amp automatic welding plant was built in the laboratory. In this plant the arc fuses only the surface of the parts welded. The addings are fused beforehand and supplied to the joint in a liquefied state.

Heterogenous metals can be joined by this method. Joints made in the laboratory include brass and bronze addings as well as hard alloys added to ordinary steel. The quality of the welds is said to be higher than ordinary, with a great increase of speed. The method is expected to enable rails with wear-resistant surfaces to be produced from low-carbon steel. It may also be applied for the mass production of cutting tools with added metal edges.

* *

Russians Use Welding to Rebuild Their Bridges

LATEST Russian five-year plan envisages the restoration of construction of 1,800 large and medium-sized railway bridges wrecked by the Nazis. To accomplish this labor of Hercules, automatic welding will be extensively applied instead of riveting in the construction of metal girder bridges.

"Use of automatic welding instead of riveting not only effects a saving in metal of 15 to 20%, but it also considerably speeds up construction," reported Professor K. G. Protasov, director of the newly created institute of bridge engi-

FOR SHIELDED ARC AUTOMATIC WELDING

RACO COMPOSITE TYPE "A"

THE NEW AND REVOLUTIONARY ELECTRODE FOR AUTOMATIC ARC WELDING

RACO Composite Type A is a heavily coated electrode in coils, providing the same physical results as heavily coated manual electrodes. With RACO Composite Type A, extremely high speeds can be obtained in any position.

It can be used with all standard automatic arc welding heads without alterations or additions.

RACO Composite Type A can be had with any of the following coatings—A.W.S. 6012; 6020; 6030 and corresponding high tensile grades. This electrode can also be furnished in three grades of hard surfacing material for building-up—RACO 25 (20-25 Rockwell C), RACO 45 (40-50 Rockwell C) and RACO 55 (50-60 Rockwell C). RACO Composite Type A Electrode is furnished in the following sizes: No. 6 (approx. 1/4"), No. 5 (approx. 7/32"), No. 4 (approx. 3/16"), and No. 3 (approx. 5/32"). Coils are 36 inches I.D., and weigh 150 to 200 pounds net.

LIGHTLY COATED AUTOMATIC ELECTRODES:—

RACO Types "D", "M", M-9 (Knurled), Plain Mill Finish and Copper Coated Wire in coils.

We draw a full line of copper coated oxy-acetylene welding wires. Furnished in coils and straightened and cut lengths.

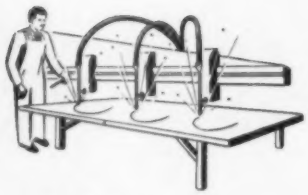
We further manufacture a complete line of heavy coated manual electrodes for welding:—Mild Steel—High Tensile Steels—Stainless Steel—Manganese Steel—Cast Iron—Nickel—Monel—Inconel and Aluminized Steel.

REID-AVERY COMPANY
INCORPORATED
DUNDALK • BALTIMORE 22 • MARYLAND

SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

FOR THESE JOBS . . .

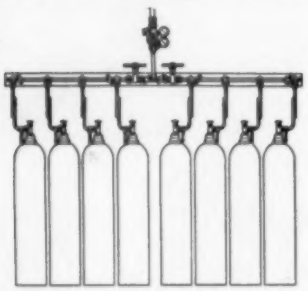
Production Welding



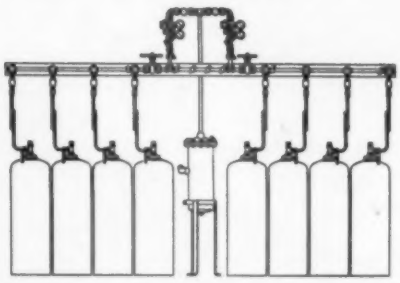
Production Cutting

. . . and operations such as welding and cutting heavy sections with hand torches, flame hardening and softening, flame cleaning . . . also any installation where a battery of cylinders is required.

YOU NEED THESE MANIFOLDS . . .



REGO
Oxygen Manifold



REGO
Acetylene Manifold

BECAUSE OF THESE ADVANTAGES . . .

- *Added Convenience* . . . Individual shut-off valves at each cylinder station permit the removal of any cylinder without shutting down one side of the manifold. Master shut-off valves control flow of each bank of cylinders.
- *Unit Construction* . . . Header assembly, mounted to steel I-beam, is virtually one piece. Extra-heavy pipe is run through header fittings, cylinder station shut-off valves and master shut-off valves, with all permanent connections silver-brazed.
- *Precision Regulation* . . . Uniform delivery pressure is assured by large capacity two-stage Regolators.
- *Exacting Tests* . . . Every RegO Manifold is subjected to a sustained air pressure test before shipment.

REGO **Manifolds for Oxygen . . . Acetylene . . . Hydrogen . . . Nitrogen and other high pressure gases.**

The BASTIAN-BLESSING Company

4201 W. Peterson Avenue **Chicago 30, Illinois**

Pioneer and Leader in the Design and Manufacture of Precision Equipment For Using and Controlling High Pressure Gases

neering in Leningrad. "Abroad this method has not as yet found extensive application owing to the lack of sufficiently perfected automatic welding apparatus. We in the Soviet Union have such a machine, invented by Academician Paton and extensively applied in construction, which makes welded bridges durable and safe. Our first efforts have been directed into the designing of model all-welded railway bridges made of various grades of steel. This work should be completed in 1947."

The new institute, the only one of its kind in the Soviet Union, will have as a "handbook" Leningrad's 450 bridges spanning the numerous canals and tributaries of the Neva river. No other city in the world has so many and so diversified an array of bridges.

* *

Airco Opens California Store and District Office

IN order to meet the increased demand for welding and cutting gases and equipment, Air Reduction Sales Co. has opened a new store and district office at 1485 Park Ave., Emeryville, Calif., near Oakland and across the bay from San Francisco. H. W. Saunders, district manager at Emeryville, is in charge.

In addition to retail sales and storage departments, the modern two-story building has space for a demonstration room where new techniques and adaptations of the oxy-acetylene flame and electric arc processes and products developed in the firm's eastern laboratories are displayed. The office is staffed by representatives trained to assist customers in the solution of welding, cutting and related problems. A complete stock of up-to-date instructional bulletins, catalogs and other welding literature is available.

* *

Install Radiant Heating in Maryland Building

COMPLETELY radiant heated, the new two-story basementless Collingwood building at St. Michaels, Maryland, that will house a restaurant and a doctor's offices on the first floor and a small private hospital clinic on the second floor. A system of welded wrought-iron piping is embedded in the concrete of the first-story floor and concealed between the sub-floor and wood finish flooring of the second story.

* *

Steel Plants Trade Production Licenses

CARNEGIE-ILLINOIS STEEL CORP., U. S. Steel subsidiary, has granted a license to Inland Steel Co., to manufacture "Cor-Ten," a corrosion-resistant, low-alloy steel developed by Carnegie-Illinois. In turn, Inland Steel has licensed Carnegie-Illinois to manufacture "Hi-Steel," also a corrosion-resistant low-alloy steel.

Weltronic Announcing

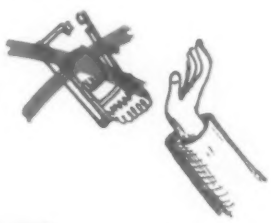
A NEW SERIES

Non-Synchronous

WELD TIMER-CONTACTORS

New electronic circuits reduce moving parts to one NEMA 00 type relay for energizing solenoid valve on welder.

OUT



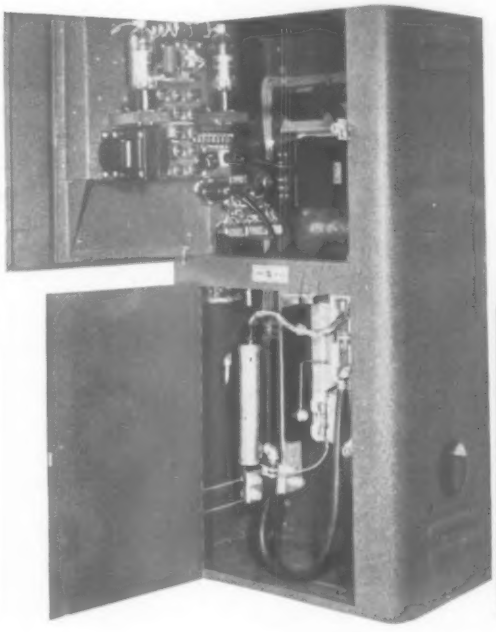
FIRING RELAY ELIMINATED

Thyratron tubes fire ignitrons direct

GONE

SEQUENCING RELAYS ELIMINATED

Replaced by tube sequencing



The start of every new weld is opposite in polarity to the finish of the last weld, thus preventing transformers from "building up" and saturating.

NO RECTIFIERS REQUIRED

Direct thyratron tube firing of ignitron contactor eliminates necessity of rectifiers. Same as on previous synchronous controls

MORE ACCURACY

Due to inherent characteristics of tube sequencing and tube ignitron firing far greater timing accuracy is obtained.

MORE WELDS PER MINUTE

Because sequencing and ignitron firing is fully electronic much of the mechanical element tending to slow up the welding cycle is eliminated. Timers can operate up to 500 welds per minute.

APPLICATION

Weltronic timer-contactors provide simple, low-cost means of accurate automatic electronic control of electrode movement and pressure, as well as duration of weld current. Use of timer-contactor relieves the operator of the timing and operating and virtually eliminates all burned welds. Models are available for foot operated spot, projection, and butt welders, including cam-timed machines.

These controls are complete "package" combination units, completely wired and ready to install. A universal wall or floor mounting cabinet houses either a NEMA 1A, 3B, or 5B timer and Ignitron Contactor.

WELTRONIC COMPANY

19500 West Eight Mile Road — **Detroit 19, Michigan**

REPAIRED IN HOURS INSTEAD OF WEEKS
WITH BRIDGEPORT NO. 192 LOW FUMING BRONZE

Weeks of time were saved by the quick repair of the flat mold illustrated, used to cast brass billets weighing about 1700 pounds. Bridgeport's No. 192 Low Fuming Bronze Rod did the job in 3½ hours!

Degasified and deoxidized, No. 192 Low Fuming Bronze Rod is well suited to repair broken parts or build up worn surfaces. It flows freely and has good "tinning" action. Brazing with Bridgeport's No. 192 makes costly preheating, slow cooling and stress-relieving unnecessary because the molten bronze adheres firmly to the clean red-hot surface of the parent metal.

Bridgeport's Bronze Welding Rods produce sound, tough repairs of high tensile strength. For complete information on the selection of alloys and brazing methods, write today for booklet, "Bronze Welding Alloys."

"Bridgeport" BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONN. • Established 1865

WELDING ALLOYS AVAILABLE

BRIDGEPORT No. 192 BRONZE—LOW FUMING
General purpose alloy. Ideal for repairing heavy-duty equipment as well as small parts—building up wearing surfaces—joining parts in industrial and construction work.

BRIDGEPORT BRONZE
Fuses readily at 1625° F. Recommended for uniting cast iron and steel parts—building up wearing surfaces—joining parts in industrial and construction work.

NAVAL BRASS
Not as high in tensile strength as Bridgeport Bronze. Suitable for repairing steel and cast iron—joining piping—building up wearing surfaces.

BRIDGEPORT MANGANESE BRONZE (NAVY)
Recommended for strength and toughness in repairing cast iron and steel castings—building up worn surfaces—joining parts in industrial and construction work.

BRIDGEPORT No. 1232 SILICON BRONZE
Used for oxyacetylene, carbon arc or metallic arc welding methods for making silicon bronze storage tanks, automatic heaters, corrosion resisting ducts, structural sections, vats, etc.

BRAZING ROD
Satisfactory for conditions that are not subject to great wear or heavy shock loads.

Bronze Welding Rod A PRODUCT OF
BRIDGEPORT BRASS

Navy Develops Flux for Silver Brazing

By using a "control flux," recently developed by the Navy Department's Bureau of Aeronautics, consistently strong silver brazes can be produced without detriment to the metal. (This flux is described in a report by Lt. A. E. Rising, Jr., USNR, covering a four-month investigation at the Naval Air Material Center, Philadelphia. Its composition consists of 50% potassium tetraborate, 30% potassium acid fluoride, 15% potassium fluoborate and 5% boric acid.

This flux was tested by torch brazing using a commercial silver solder known to present a difficult fluxing problem. It is believed to satisfy all requisites of a standard flux for silver-brazing alloys flowing at temperatures up to 1,300 F and, with some limitation in flux film persistence, up to 1,400 F.

Orders for the report (PB-40296) "Control Flux Composition for Silver Brazing" —Navy Specification 51F4 should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D.C., accompanied by check or money order (photostat, $3; microfilm, $1) payable to the Treasurer of the United States.

* *

Test Jet Engine Parts in Bombproof Shelter

In a bomb-proof dugout at the Westinghouse Laboratories, scientists soon will begin to explode whirling, red-hot disks of hot metal in an effort to determine the maximum strength of parts for aircraft engines.

Disks of specially-developed alloys, one foot in diameter and one inch thick, will be heated to temperatures above 1,400 F and spun at the blurring speed of 1,200 miles per hour—35,000 rpm—until they literally fly apart under the combined attack of centrifugal force and heat.

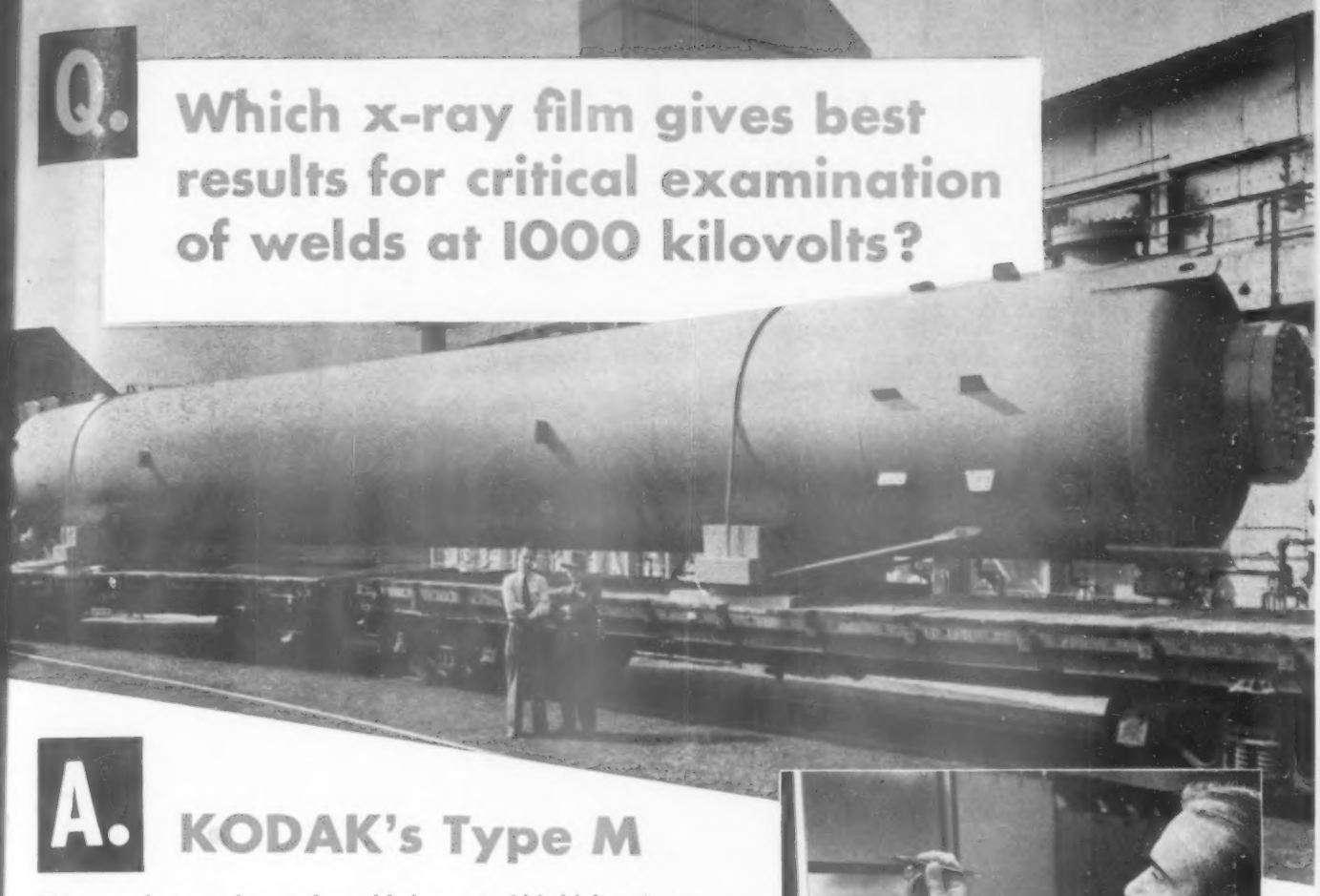
As the heated disk spins, research engineers will make continuous measurement of its temperature. Methods for doing this posed a difficult problem. Since the disk is whirling at the rate of 35,000 rpm, any thermocouple attached to the outer rim would have a centrifugal pull of approximately 190,000 times its own weight and would have to be fastened strongly enough to resist a pull of many thousand pounds. The problem was solved by welding the thermocouple in place by means of a special jig.

* *

Amsco Opens New Sales Office

A new sales office has been opened by American Brake Shoe Co., at 1500 Walnut St., Philadelphia, and occupied by representatives of four divisions of the company. These men are: James J. Nelson, National Bearing; Thomas N. Mitchell, district manager, Kellog division; L. John Harwood, Electro-Alloys; George E. Anne, Brake Shoe & Castings.

Q. Which x-ray film gives best results for critical examination of welds at 1000 kilovolts?



A. KODAK's Type M

This manufacturer *knows* the welded seams of his high-pressure tank are sound.

How does he know? He has seen and studied the internal structure of those welds with radiography . . . using Kodak Industrial X-ray Film, Type M, with lead foil screens to do the job.

Why Type M? . . . Because short exposure time was not important—and because Type M, with its extra-fine grain and highest available contrast, makes possible radiographs that have exceptional detail and maximum sensitivity . . . both so essential in determining the soundness of welds.

But if short exposure time *had* been important? . . . Kodak Type A would have been the choice—because with its fine grain and equally high contrast it has considerably increased speed.

Radiography more than pays its way. To find out what radiography means to profits, just look around you, at other plants, other welding shops. You'll see how it enables them to prove the soundness of their welds quickly and thoroughly . . . how it guides welders to better technics . . . how it prevents costly failures and customer rejections.

Then—to find out exactly how radiography can do these same things for you—consult your local x-ray dealer, or write . . .

EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N. Y.

Inspecting radiographs of welds for nonhomogeneities

Other Kodak Industrial X-ray Films

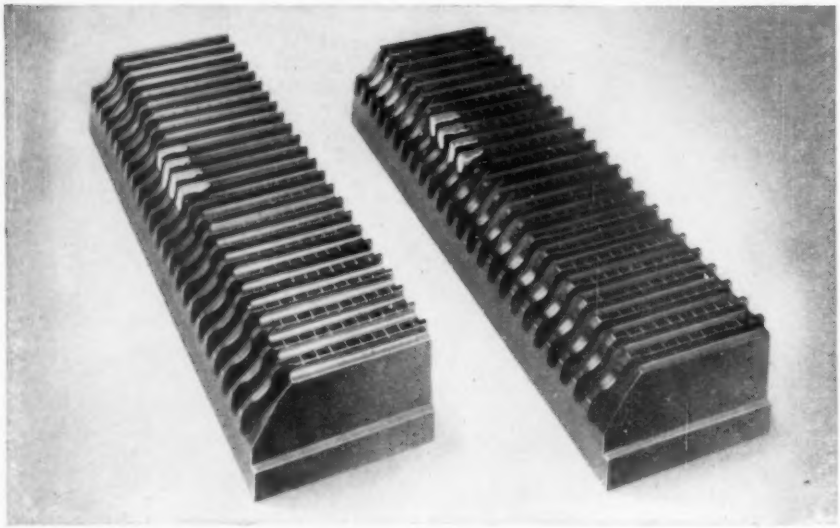
Kodak Industrial X-ray Film, Type F . . . with calcium tungstate screens—primarily for radiography of heavy steel parts. The fastest possible radiographic procedure.

Kodak Industrial X-ray Film, Type K . . . primarily for gamma- and x-ray radiography of heavy steel parts, or of lighter parts at limited voltages where high film speed is needed.

Radiography . . . another important function of photography

Kodak

$825 WORTH OF BROACH INSERTS REPAIRED AT COST OF ONLY $10



Cutting tool life greatly prolonged with use of Eureka No. 2 H.S.S. welding rods . . .

The large high-speed steel broach inserts pictured above, valued at about $825, were rendered useless because of four broken corners in the cutting flutes. Yet these same inserts were quickly repaired by welding and at a cost of only $10! The answer? *Eureka No. 2 H. S. S. welding rods!* Cutting edges were built up, then finish ground and the inserts were as good as new! Deposits of Eureka No. 2 are "hard-as-welded", have excellent cutting characteristics and abrasive resistant qualities which are often better than typical high-speed steels. No subsequent heat-treatment necessary.

Eureka No. 2 H.S.S. welding rods are now being widely used for *repairing* or *compositely fabricating* H.S.S. *cutting tools* and for *creating cutting, wearing and bearing surfaces.* Saves time, money, man hours! Write for literature now!

EUREKA ELECTRODES WILL DO IT—OR WE DON'T FIND THE WORK

Welding Equipment & Supply Co.

MEMBER AMERICAN SOCIETY OF TOOL ENGINEERS

PIONEERS IN TOOL AND DIE WELDING ELECTRODES

NEW EUREKA HIGH SPEED STEEL WELDING RODS BULLETIN

Eureka No. 2 High Speed Steel Welding Rods repair high speed steel cutting tools, compositely fabricate, create cutting, wearing or bearing surfaces. Procedures given.

Welding Equipment & Supply Co.
223 Leib Street,
Detroit 7, Michigan

Rush me Bulletin explaining use of No. 2 High Speed Welding Rods.

Name_____

Address_____

Title_____

City_____ State_____

Carnegie-Illinois to Hold Open Houses at Steel Works

CARNEGIE-ILLINOIS STEEL CORP., expects to play host to more than 100,000 visitors from Chicagoland when it holds open houses at its South Chicago Works and Gary Steel Works on May 14 and May 21–22, respectively. The general public is invited to attend the affair at each of these plants, which are among the world's largest. Visitors will see the blast furnaces, including the three new and larger stacks the company is building at both plants, the 87 open-hearth furnaces, Bessemer convertors and rolling mills. Gary Works guests will see railroad rails being rolled from five-ton ingots.

* *

Magnaflux Corp. to Hold Weld-Inspection Conference

A CONFERENCE to discuss the use of magnetic-particle inspection in the welding field will be staged in Chicago, at the Congress Hotel, under the sponsorship of the Magnaflux Corp., on May 8 and 9.

Meetings will take the form of an open forum, with discussion leaders selected from the various fields which use this inspection method or the fluorescent-penetrant method to inspect welds. Further information can be secured from W. E. Thomas, Magnaflux Corp., 5900 Northwest Highway, Chicago 31.

* *

Beaverdell Incorporates and Changes Firm Name

BEAVERDELL CO., Chicago manufacturer, has incorporated and will henceforth be known as Beaverdell, Inc. Officers under the corporate set-up are E. C. Johnson, president; J. W. Johnson, vice-president; John D. Kamp, secretary-treasurer.

Beaverdell, Inc., has acquired a franchise from Steele Gases, Inc., Chicago, for the distribution of oxygen, acetylene, hydrogen, nitrogen and carbon dioxide and another franchise from Weldit, Inc., Detroit, for distribution of the Weldit line of welding and cutting equipment.

New Distributors

Wall Colmonoy Corp., Detroit 3: L. P. Okelberry, Murtaugh, Idaho; Middlesex Welding Supply Co., New Brunswick, N. J.; Essex Welding Equipment Co., Newark, N. J. (distributors of hard-facing alloys and "Spraywelders").

* *

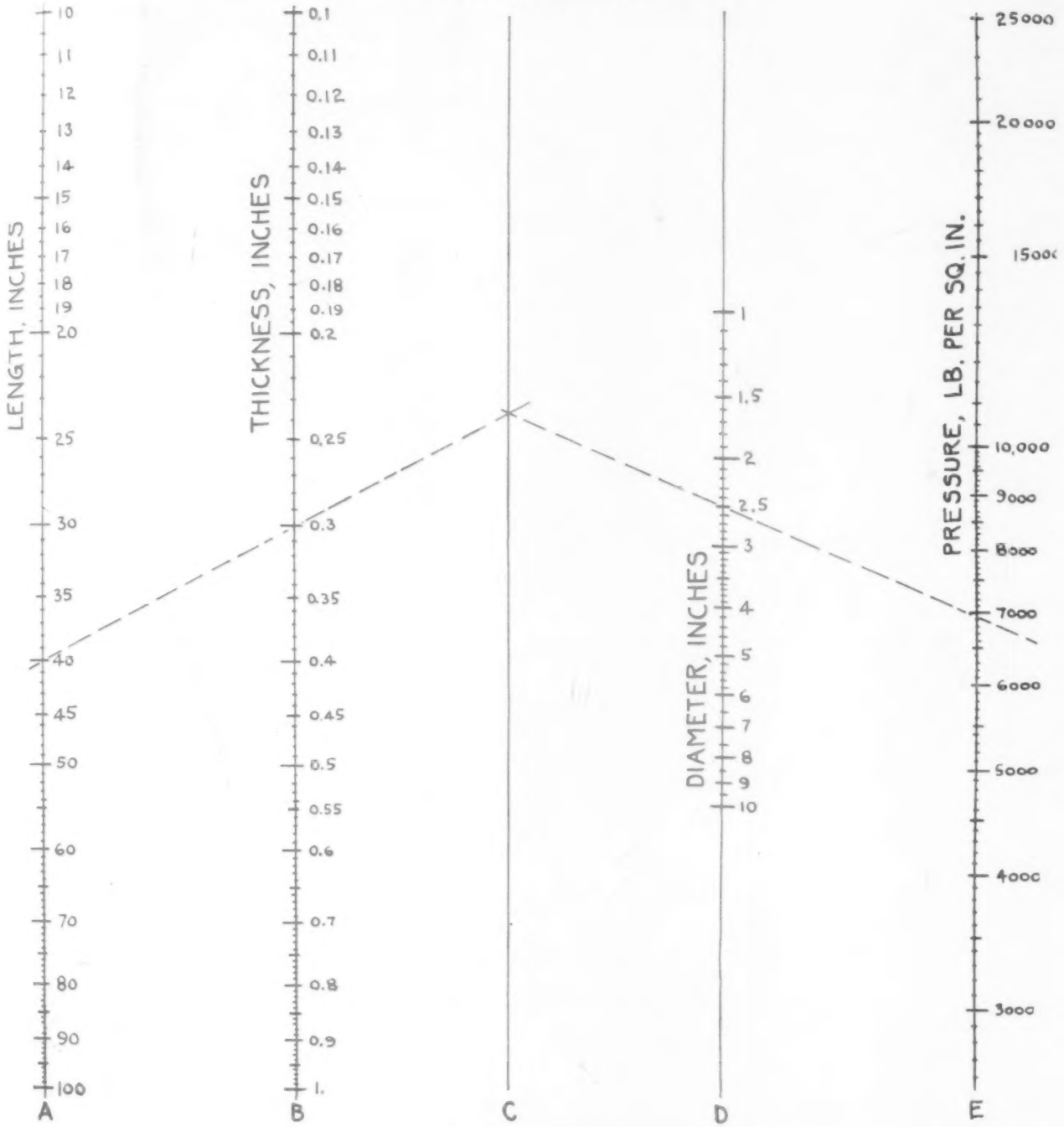
Titan Metal Mfg. Co., Bellefonte, Pa.: Paul R. Spencer & Co. 4000 York St., Denver, Colo. (distributor for all Titan brass and bronze products).

* *

Precision Welder and Machine Co., Cincinnati, O.: Hosler and Co., Indianapolis; Machinery & Welder Co., Chicago; J. A. Cunningham Equipment Co., Philadelphia; and Canadian Fairbanks Morse Co., Ltd. (distributors for spot, seam, flash, projection and portable welders).

Collapse Resistance of Pipes

BY W. F. SCHAPHORST, M. E.



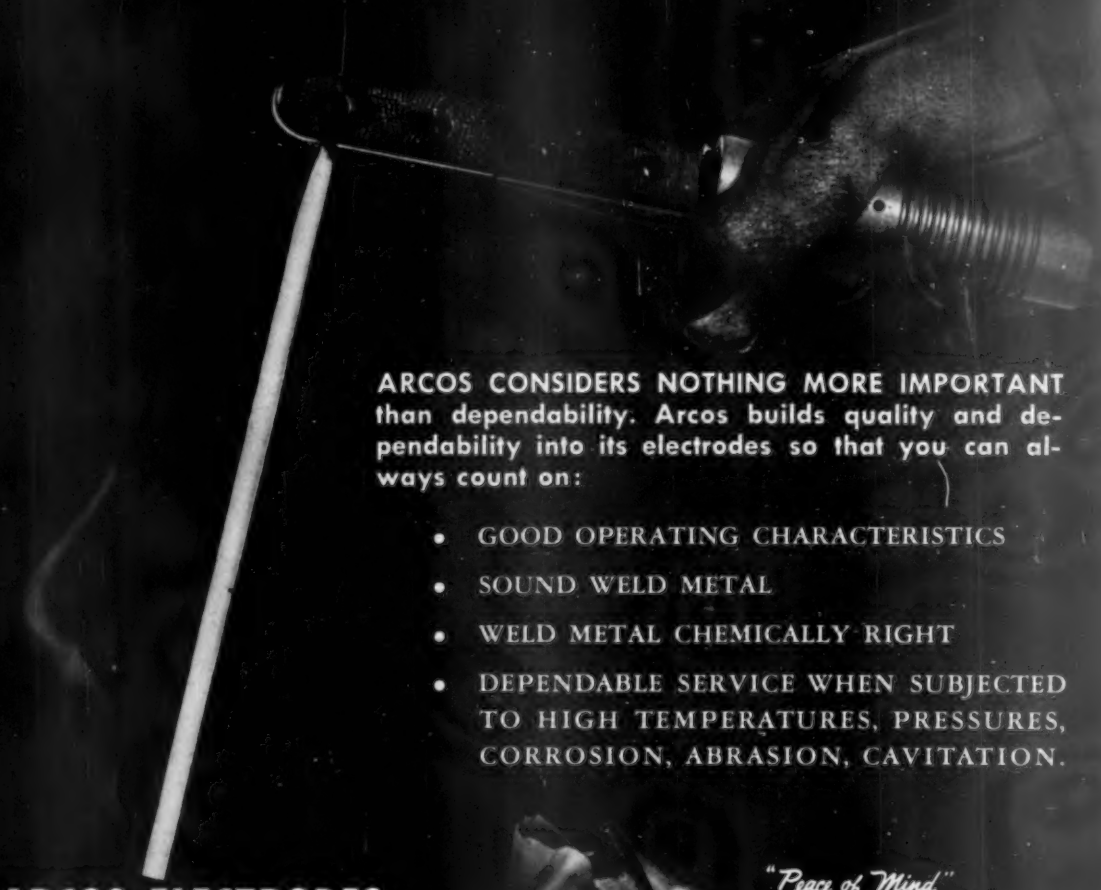
It is frequently necessary to know the external pressure at which steel pipes or tubes are likely to collapse. The answer can be derived from one of the multitude of formulas found in engineering handbooks. To make it easier, however, for engineers and non-engineers alike, the writer has developed the accompanying chart.

This chart is intended to show the external pressure which has a tendency to collapse a steel tube or pipe of specified length, diameter and wall thickness. Any one of these four variables can be readily found wherever the other three are known quantities.

Example: What external pressure can be safely withstood by a 2.5-in. pipe, 40 in. long and 0.3 in. thick? To solve this problem draw a straight line through the 40 in column A and the 0.3 in column B and prolong this line to intersect with column C, as shown by the left dotted line. Draw a second line from the point of intersection through the 2.5 in column D, as shown by right dotted line; the intersection of the second line with column E gives the result—in this case about 6,950 psi.

The chart can also be used to determine pipe length, thickness or diameter. Using the previous example, let us suppose that we wish to find the thickness of 2.5-in. pipe necessary to withstand a pressure of 6,950 psi where the pipe length is 40 in.; the same dotted lines will show the required thickness (column B) to be 0.3 in.

WHAT IS MORE IMPORTANT THAN
DEPENDABILITY
IN THE WELDING OF STAINLESS AND ALLOY STEELS?



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STAINLESS AND ALLOY WELDING ELECTRODES

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1950-1960

The Twentieth Century Fund, a privately-endowed research foundation, has just completed a monumental 875-page work called "America's Needs and Resources." In it is presented a detailed preview of what economic life in the U. S. A. during the 1950-60 decade will be like if we succeed in maintaining high-level employment. From the findings of the Twentieth Century Fund survey, the McGraw-Hill Department of Economics has prepared this synopsis, which highlights points of interest to readers of this magazine.

MORE PEOPLE WORKING . . .

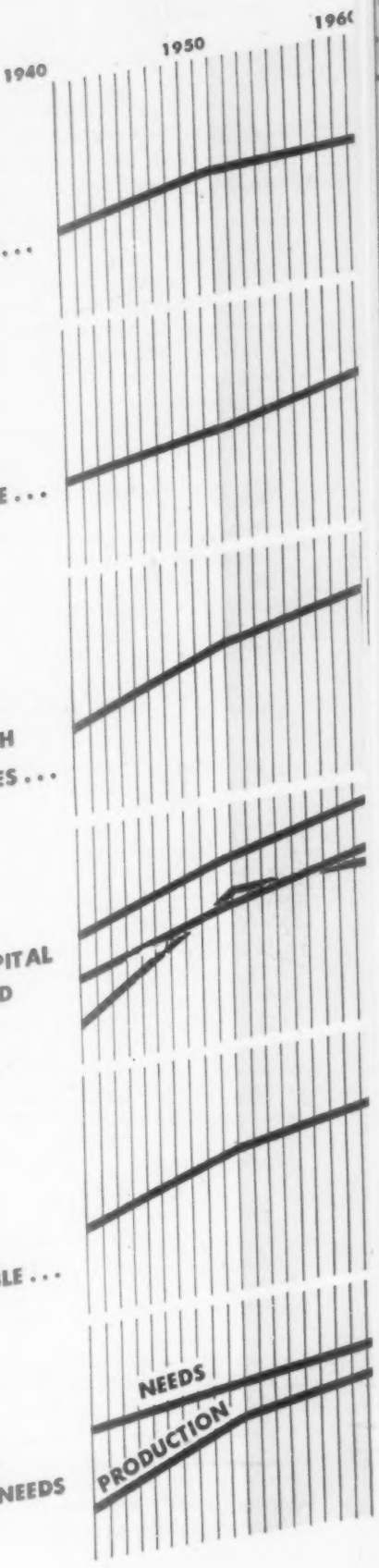
EACH PRODUCING MORE . . .

CAN TURN OUT ENOUGH GOODS AND SERVICES . . .

FOR CONSUMERS, CAPITAL INVESTMENT AND GOVERNMENT

WITH THE RESOURCES AVAILABLE . . .

TO MEET ALMOST ALL OUR NEEDS



POPULATION

A nation's wealth depends more than anything else on the size and vigor of its population. Much of the increase in U. S. production during the past hundred years is a result of a rapid growth in population. This growth supplied manpower for farms and factories and provided an expanding market for consumer goods and services.

MORE PEOPLE WORKING . . .

Growth was the outstanding fact about population before 1930. The birth rate was almost double the death rate and there was a heavy flow of immigrants. Between 1900 and 1930, the population increase averaged 15 million each decade. Immigration contributed a third of the increase.

But this trend was checked by the depression 30's which stemmed the flood of immigrants and cut the birth rate by forcing postponement of many marriages. As a result, fewer than 9 million persons were added to the population between 1930 and 1940. This was an important factor in prolonging the depression because it slowed the growth of consumer markets.

WARTIME MARRIAGE BOOM

War and postwar conditions have brought a boom in marriages. They have exceeded normal by more than 1,500,000 since 1940. There will be more newly-married couples in 1950 than ever before and the birth rate may be roughly 10% higher than in the early 1930's. So the 20th Century Fund looks for an increase of 12 million in total population between 1940 and 1950 and a further increase of 10 million in the 1950's.

This will mean a faster-growing market for homes, autos, food, clothing, and other consumer items than we had in the 1930's. It will mean crowded schools and more people seeking jobs.

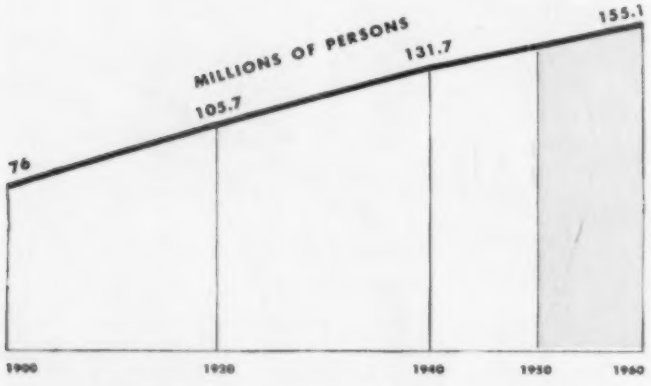
There are four major population trends which will affect markets in the 1950's:

1. The number of families will continue to increase more rapidly than the number of people as families grow smaller. This is significant because the market for housing, appliances, and many other things depends more on the number of families than on the number of people.

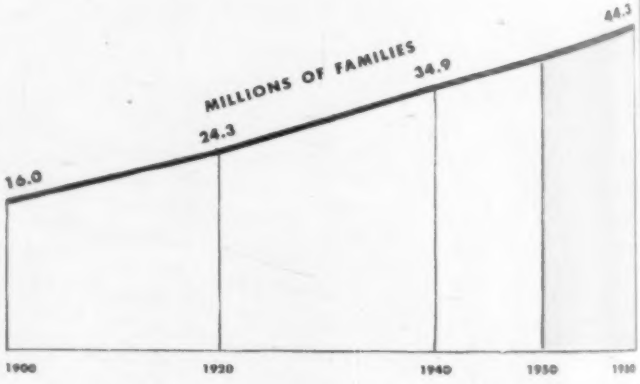
2. Our population will be getting older. But it will not be getting less productive because the proportion of the population between the ages of 20 and 60 will be higher than in past decades. Still, the most striking increase will take place in the number of people over 60—from 14 million in 1940 to more than 20 million in 1960. This will bring greater demand for medical services and social security. An important cause of this trend is our success in controlling communicable disease. The following table shows how the death rate from selected causes has changed since 1900.

	Death Rate Per 100,000 Persons	
	1942	*1900*
Diseases of heart	295	137
Cancer and other malignant tumors	122	64
Influenza	56	202
Tuberculosis	43	194
Diarrhea and enteritis	9	143
Whooping cough	2	12
Diphtheria	1	40
Measles	1	13
Typhoid and paratyphoid fever	0.5	31
Scarlet fever	0.3	10
Other	505.2	873
	1035.0	1719

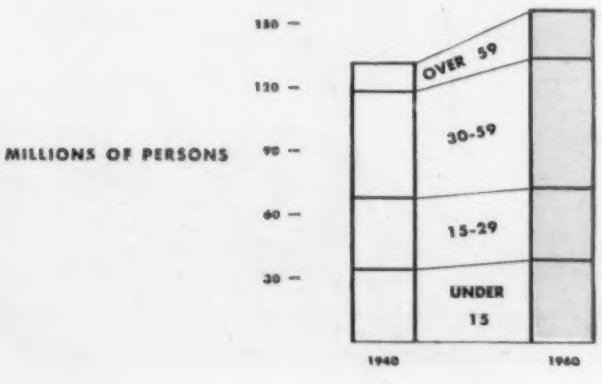
TWICE AS MANY PEOPLE



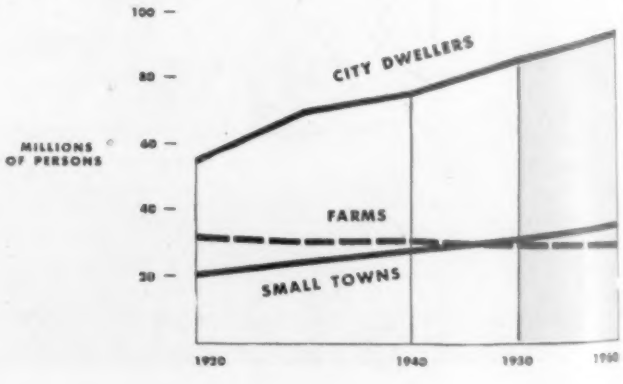
BUT THREE TIMES AS MANY FAMILIES



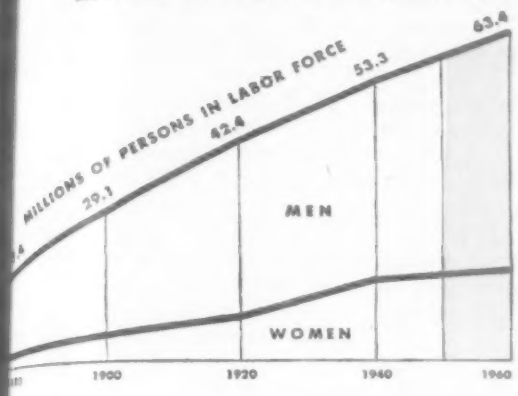
MORE OLDER PEOPLE



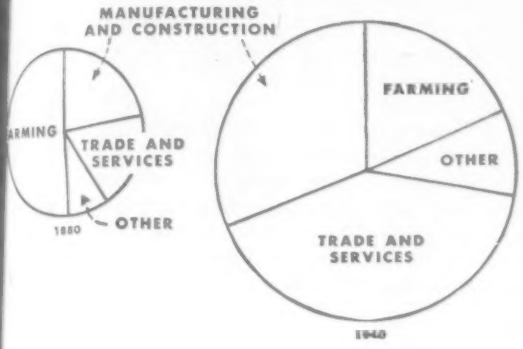
MORE CITY DWELLERS



MORE AND MORE WOMEN ARE SEEKING JOBS

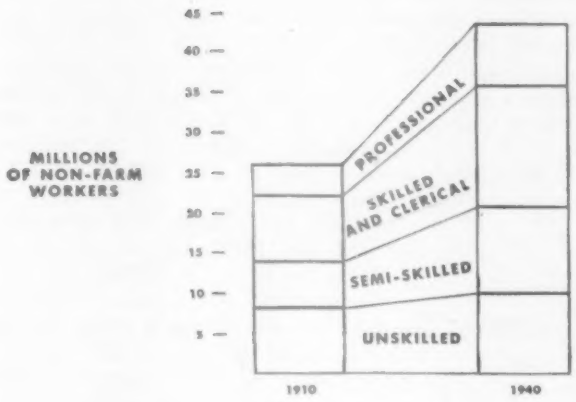


FARMING IS GIVING WAY TO OTHER OCCUPATIONS



ANATOMY OF THE LABOR FORCE

THE LABOR FORCE IS GROWING MORE SKILLED



3. The population will continue to become more urbanized. Small and medium-sized cities will grow faster than the largest cities. The general westward migration which was accelerated by the war will continue.

4. Our people will keep on getting more homogeneous. There has been almost no immigration since 1929, so the number of immigrants who have been in the country for less than 20 years will make up less than one percent of the population in 1950 as against 10% in 1930.

An even more important factor in making the population all of a kind has been the growth of universal education. The proportion of children 14-17 years old attending high school doubled between 1920 and 1936. The rise of the radio, movies, and national magazines has also levelled us out. These developments not only raise the general educational level of the nation but also tend to standardize the public's tastes and attitudes.

LABOR FORCE

The volume of goods and services produced by 145 million persons in 1950 and 155 million in 1960 will depend on what share of the population is in the labor market and the amount of work those employed actually do. The proportion of the population in the labor force has shown little change in the past few decades. So the 20th Century Fund assumes that the relationship between labor force and population will be about the same in 1950 and 1960 as it was just before the war. On this basis 60 million people will be in the labor market in 1950 and 63.4 million ten years later.

As you can see from the charts, however, there will be several important changes in the composition of the labor force. More women will be working. In 1870 only one out of every eight worked. By 1940 the proportion had grown to one out of four, and evidently will go on rising.

However, the increase in the number of women working will just about be offset by earlier retirements and longer schooling. This explains why there is little change in the ratio of labor force to population.

UNEMPLOYMENT

The effectiveness of the labor force depends not only on its size but on how fully it is employed. We have never had full employment in the sense that everyone able and willing to work had a job at the same time. Even in good years unemployment has seldom averaged less than 5% of the working force because workers are always moving from job to job. And in 1932, nearly one-fourth of all workers were unable to find jobs.

For this reason, the 20th Century Fund assumes that, even with good business in the 1950s, unemployment will average 5% of the labor force. This works out to 3 million unemployed in 1950.

In addition, the Fund expects the long down-trend in average weekly hours to continue. A century ago, workers put in a 12 hour day for 6 days a week. By 1940 the average work-week had declined to 44 hours in non-agricultural jobs and 52 hours in agriculture. If this trend continues, the average in non-farm jobs will be down to 38 hours a week in 1960, and farmers will work 48 hours.

Adding all this up, and allowing for vacations, absenteeism, and sickness, the 20th Century Fund estimates that the U. S. will put in 121 billion man-hours of work in 1950 and 118 billion in 1960. This compares with 105 billion in 1940 and with 154 billion at the peak of the war effort. The quantity of goods and services that can be turned out with this amount of labor effort will depend on average output per man-hour, or productivity.

PRODUCTIVITY

The key to our future economic welfare is productivity. It is the five-fold increase in output per man-hour that has made it possible for us to work shorter hours and still enjoy a rising standard of living. This increase in productivity has been accomplished not by working harder but by constantly inventing better machinery to supplement human energy with mechanical power.

Of course, in any specific factory at any given time, productivity depends largely on the willingness and ability of labor and management. But over the years, the actual effort of the individual worker becomes much less important than the effort of the machine. The most energetic and skilled blacksmith of a century ago could not remotely approach the productivity of today's semi-skilled worker operating automatic power-driven equipment.

EACH PRODUCING MORE . . .

In 1860, the average worker turned out 33¢ (in 1944 dollars) worth of goods in an hour. By 1940, this had grown to $1.22. This sensational increase in productivity was due to the increased use of power-driven machines. In 1860, the average worker had the help of only half a horsepower of animal or mineral energy. In 1940, he had the use of 2.7 horsepower. To put it another way, if there had been no increase in the use of mechanical power since 1850, it would have taken 290 million workers to turn out the amount of goods and services actually produced at the peak of the war effort by only 63 million workers.

DO MACHINES KILL JOBS

Past history also shows that we need not fear the long run effects of the introduction of labor-saving machines. On the contrary, the only way we can improve the material welfare of everyone is to continue and even step up the rate at which we save labor by using machines.

Some people, it is true, are thrown out of work and a few of them may not be able to find other jobs easily. But mechanization more than compensates for "technological unemployment" by making it possible to produce more and better things for everyone—things that themselves create jobs. Development of the railroads and the automobile, for example, put a lot of canal boat and livery stable operators out of business. But it cut the cost of transportation and created many times more jobs than it eliminated.

The 20th Century Fund also points out that the most important reason that the technological revolution developed luxuriantly in the U. S. between 1850 and 1940 was that competitive enterprise provided a generally favorable climate. It is true that natural resources were plentiful and that the population was growing rapidly both in numbers and in skill. But what we had to a unique degree here was an atmosphere which favored risk-taking, fostered the vast capital investment necessary to harness and apply mechanical energy, and provided the incentives necessary to put capital and inventiveness to work.

No other economy has equalled ours in the ability to produce more and more with continually diminishing human effort. The test it now faces is whether it can eliminate the ups and downs in production and employment that have gone along with it. But an abundance of evidence indicates that we ran into trouble after 1929 not because we developed too many labor-saving machines but because we didn't adjust our economic mechanism to keep the process going.

The key importance of mechanization is indicated by the fact that the increase in national production since 1860 closely parallels the increase in use of mechanical power. Between 1860 and 1940, both volume of production and use of energy multiplied about 11 times. It is clear that, in order to keep our standard of living rising, we must continue to apply more and more power to production.

Chief advantage of mechanical energy is, of course, its low cost. Electric energy is now delivered for as little as a cent a horsepower, while the same amount of human energy costs $10.

And there are other important advantages. Mechanical energy can be delivered in greater concentrations than any other form. It is also more convenient, compact, mobile, and controllable. Consolidated Edison in New York delivers enough electricity in a day to do the work of 3 million draft horses.

These advantages are now so universally accepted that it's hard to realize how recently we left the horse and buggy era. At the turn of the century, animals and men provided more than half the energy used in production and transportation. It wasn't until World War I that trucks replaced horses in local hauling and tractors began to invade the farms. Here is how the use of mechanical energy has grown since 1850:

	Total Energy Output (Billions of Horsepower-Hours)	Percent Supplied by:		
		Mechanical Energy	Humans	Animals
1850	17.6	6	15	79
1860	25.2	7	14	79
1870	27.8	12	15	73
1880	39.9	17	14	69
1890	61.1	28	12	60
1900	82.9	38	10	52
1910	131.4	57	8	35
1920	197.4	73	6	21
1930	238.3	84	5	11
1940	289.4	90	4	6
1950	410.4	94	3	3
1960	489.8	96	2	2

PRODUCTIVITY IN THE FUTURE

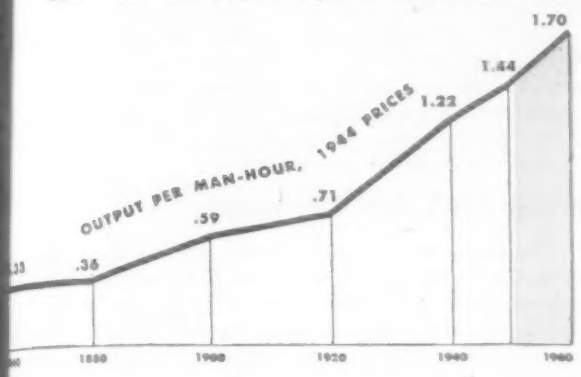
Any attempt to predict future developments in productivity is complicated by the fact that the changes do not occur at an even rate. Between 1850 and 1940 the average increase in output per man-hour was 18% per decade. But the changes varied all the way from 3% between 1870 and 1880 to 42% for the decade ending in 1940. There is, therefore, no simple way to extend past trends to obtain a foolproof figure for productivity at a future date.

For purposes of this study, however, the 20th Century Fund assumes that the average rate of increase since 1850 may be projected to estimate output per man-hour in 1950 and 1960. Thus, output per man-hour works out to $1.44 in 1950 and $1.70 in 1960 as against $1.22 in 1940 (all in 1944 dollars).

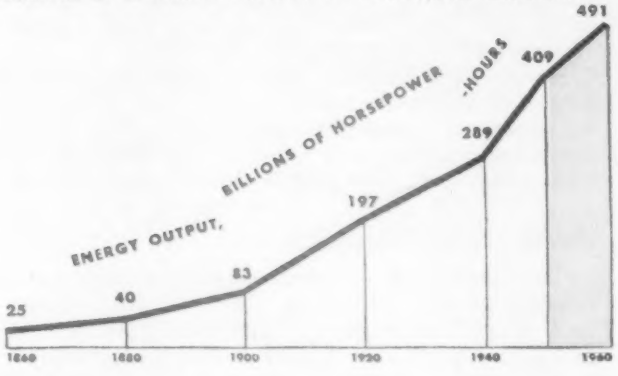
As the Fund points out, this is a critical assumption, and it is further complicated by the fact that there is a wider possibility of error in this estimate than in most of the others in the study. If, for example, it is assumed that productivity will increase at the pace set from 1920 to 1940 which averaged 36% per decade, then 1960 production would be about double the 1940 level instead of only 157% of it, as the 20th Century Fund estimates.

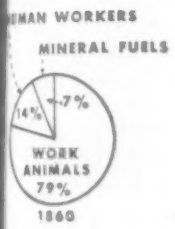
A CENTURY OF ECONOMIC PROGRESS 1860 – 1960

OUTPUT PER MAN-HOUR SHOULD BE 5 TIMES AS GREAT

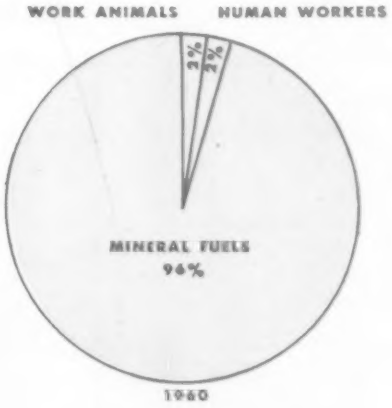


BECAUSE OF A STEADY GROWTH OF POWER AND MACHINES

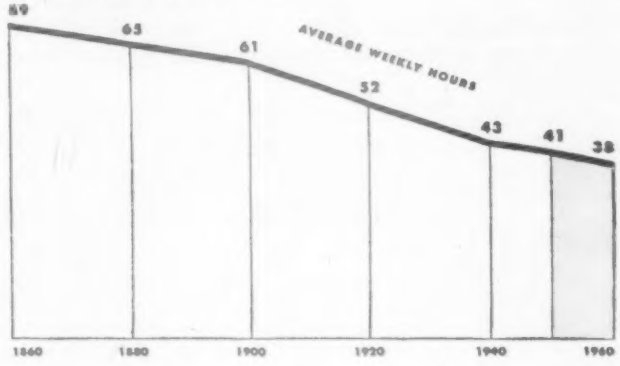




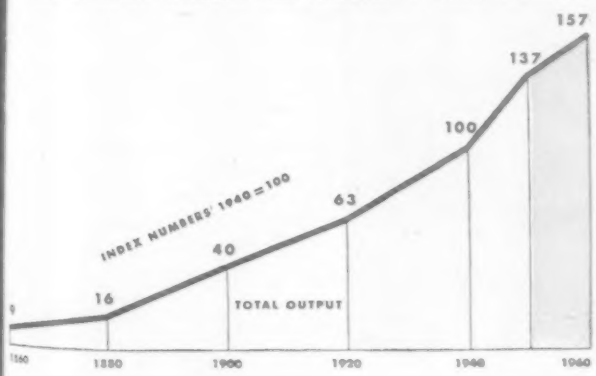
SO WITH LESS EFFORT



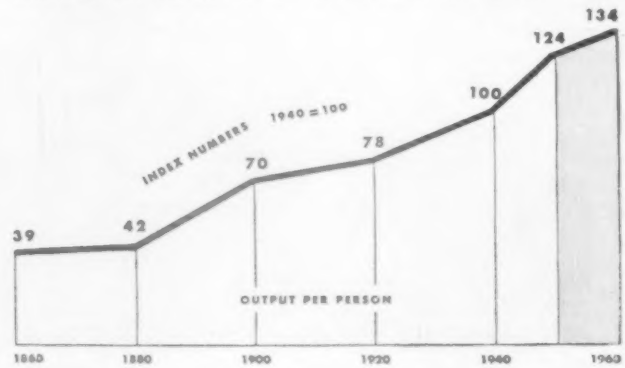
AND A SHORTER WORK WEEK



TIMES AS MANY WORKERS CAN PRODUCE 17 TIMES AS MUCH



AND PROVIDE 3½ TIMES AS MUCH OUTPUT FOR EACH PERSON



TOTAL NATIONAL OUTPUT

The potential volume of goods and services in 1950 and 1960 can be determined by simple arithmetic, using the assumptions outlined on the preceding pages. Of an estimated population of 145 million in 1950, about 60 million persons will be in the labor market and 57 million of them will have jobs if we succeed in keeping business activity at a high level.

This many people would work 121 billion man-hours. With output per man-hour estimated at $1.44 (in 1944 dollars) the total value of goods and services produced, or the gross national product, would come to $177 billion. Similar calculations yield a gross national product of $202 billion for 1960.

As the 20th Century Fund emphasizes, these estimates are neither a forecast of actual production nor an appraisal of maximum potential production. They are merely an attempt to show in dollars and cents what can be achieved with high-level employment.

HIGHER LIVING STANDARDS

Compared with any prewar year, a gross national product of $177 billion in 1950 and $202 billion in 1960 would represent a handsome gain. It would make possible a substantial rise in living standards. In 1950 we would produce a fifth more than in 1941.

CAN TURN OUT ENOUGH GOODS AND SERVICES . . .

However, the volume of goods and services turned out in 1950 would be only slightly higher than present production. This is because the number of persons at work today is 2 million above the estimated normal for 1950, and average weekly hours are higher than they will be then. Almost a million and a half of the emergency workers dra into the labor force during the war are still at wo and unemployment is lower than the figure assum for 1950.

The estimates of 1950 and 1960 gross national pro uct, as well as the figures for past years used in t chart, are expressed in 1944 prices. This is not a p diction that the price level will settle down to the 19 level which would involve a drop of 18% in the c of living and 26% in wholesale prices. It is merely device to eliminate price fluctuations so that the f ures will show only the actual changes in the physi volume of production.

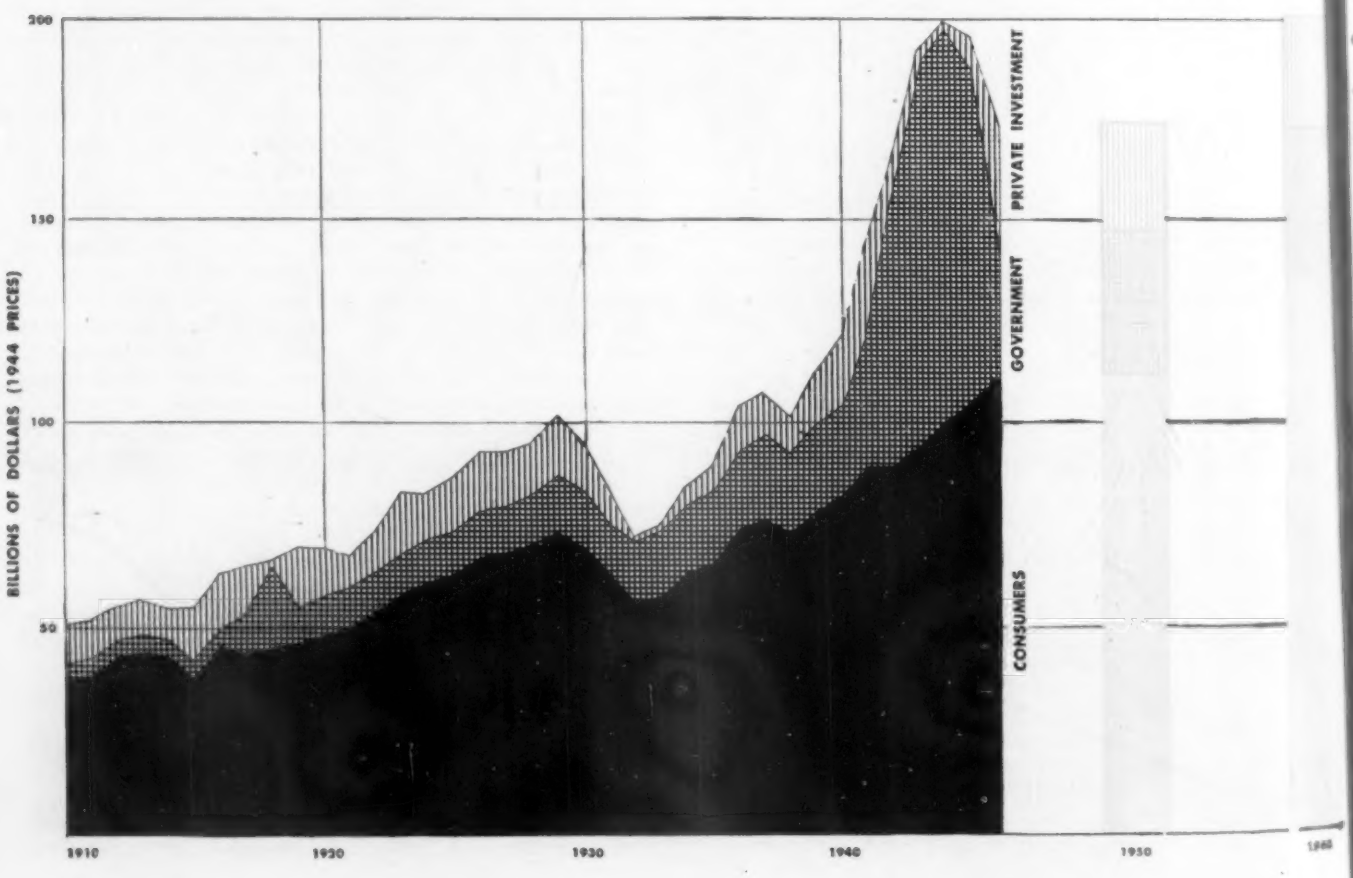
Gross national product measures the total mark value of everything the nation produces. All t goods and services produced are absorbed in one three ways: by consumer expenditures; by expen itures for investment in capital goods or inventorie or by government expenditures.

HIGHER TAXES, LESS INVESTMENT

The division of total output among consumers, i vestment, and government will be somewhat diffe ent in 1950 and 1960 than in the past. About tw thirds of total output will go into consumer goo and services. This is about the same as the propo tion in prewar years.

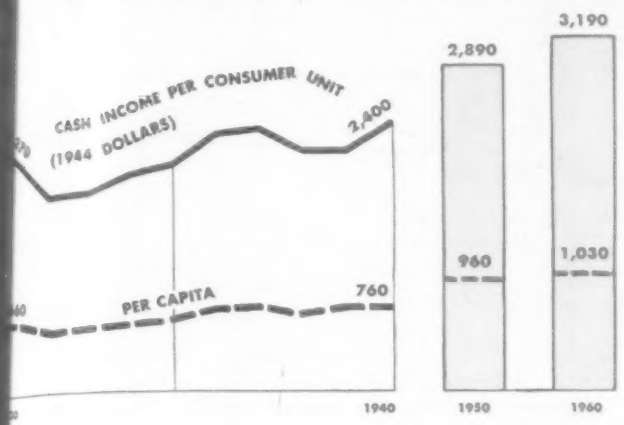
Government's share will continue to grow, how ever. It rose from 11% of total output in 1929 t 17% in 1940. At the peak of the war effort, half a all production went to Uncle Sam. Government ex penditures have dropped to less than half the w peak and they will continue to decline slowly. Be government's share will still run to around 20% in th 1950's. On the other hand, the ratio of investment t total output shows a slight long term decline.

HOW TOTAL OUTPUT IS DISTRIBUTED

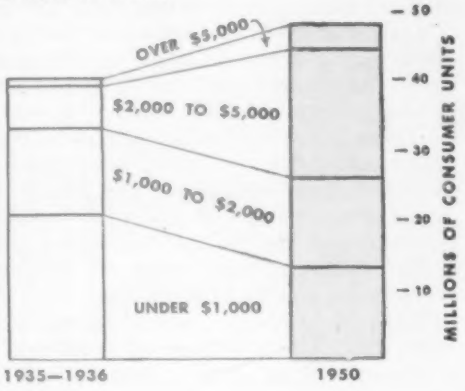


MORE CONSUMER PURCHASING POWER

CONSUMERS WILL BE ABLE TO BUY 50% MORE THAN IN 1930'S



EVERY OTHER FAMILY... INSTEAD OF EVERY SIXTH FAMILY... WILL HAVE $2,000 OR MORE TO SPEND.



CONSUMER INCOME

U. S. business can look forward to a 1950 consumer market twice as large as in the worst year of the depression, half again as large as in 1929, and one-fifth larger than in 1941. That is the major conclusion of the 20th Century Fund's analysis of consumer purchasing power. Here are the steps by which it arrives at that conclusion:

1. With gross national product at $177 billion in 1950, past experience indicates that income payments to individuals would run to $138 billion.

2. Income tax rates are assumed to equal the 1942 schedules, so individuals would pay $11 billion in taxes (as against $19 billion in 1946).

3. Savings are estimated at $12 billion, or about 9% of income after taxes.

4. Subtracting taxes and savings, consumer purchases of goods and services would total $116 billion.

LOWER SAVINGS

Many experts would criticize the assumption that savings will amount to only 9% of income. Some of them look for a ratio as high as 20% in prosperous postwar years. The 20th Century Fund justifies the use of a low figure on three grounds: (1) people built up reserve of savings during the war; (2) expanding social security will reduce the need to save for old age; and (3) taxes will cut into savings. The Fund's estimate of savings plus taxes in 1950 adds up to a higher percentage of income than in prosperous prewar years.

The standard of living won't rise as rapidly as the total income going to consumers, because the increased income will be split up among more family units. But the average consumer unit (a family or a single person living alone) will be a third better off in 1960 than in the 1930's.

Shifts in the distribution of income will be even more important, from a marketing standpoint, than the general increase in over-all consumer income. More consumer units will be in the over-$2000 brackets than ever before and this group will be receiving a much larger share of total consumer income.

Part of the apparent increase in income is cancelled out by higher prices. To show the actual increase in purchasing power, the figures should be adjusted for an estimated one-third increase in the 1950 price level over that of the mid-1930's. This would mean that a $2,650 income in 1950 would buy no more than a $2,000 income in 1935-36. Even if this adjustment is made, the resulting figures still show a striking upward shift.

Income Class	Consumer Units in Millions		Cash Income in Billions	
	1935-56	1950	1935-36	1950
Total	39.2	47.9	$85.0	$135.0
Under $1000	20.8	13.0	17.0	7.7
$1000-2000	12.2	12.9	28.1	21.5
$2000-5000	5.5	18.2	23.8	62.1
Over $5000	0.7	3.8	16.1	43.7

In addition to dollar income, shown in the above table, consumers also receive "income in kind"—food and fuel produced by farmers for their own use, board and lodging received by domestic servants. Such income will have a value estimated at $3.3 billion in 1950, most of which will supplement the $7.7 billion received by those in the "under $1000" bracket.

FOR CONSUMERS.

The urban market will continue to be far more important than the rural market. Consumer units in cities will receive cash incomes of $3,445 on the average in 1950, more than twice the farm average of $1,635 and almost twice the small town average of $1,880.

THE FARM MARKET

These figures don't provide an accurate measure of the relative importance of the rural and urban markets because rural consumers pay a lot less for food, fuel, shelter and so have more to spend for other things. If there were any way to adjust for these things, the figures would show a smaller spread between the two markets, but the urban market will still be dominant.

All these figures underline a general upgrading in consumer demands which would accompany high-level production and employment. It will have a profound effect on marketing practices. The average person will eat better, dress better, and live in a better house with better equipment. And he will have more money to spend for travel, recreation, and luxuries.

CONSUMER MARKETS

The improvement in living standards during the 1950 decade will lead to important changes in the way consumers spend their dollars. Even though they will eat better, dress better, and live in better houses, a smaller share of the consumer dollar will be spent on food, clothing and shelter. A growing share will go for appliances, furniture, travel, and recreation.

This means that the fastest growing markets will be those providing what might be called "optional" goods and services — things which add to comfort and enjoyment but which are not strictly necessary. Markets for necessities, on the other hand, will expand at a slower rate than total consumer expenditures.

The growing importance of "optional" goods and services is one of the reasons why it's increasingly difficult to keep our economic machine going on an even keel. The purchase of "optional" goods can be postponed with little hardship. So anything that causes people to put off buying a new car, a new house, or a new radio has a far greater effect on production and employment now than it did when the major share of the consumer dollar went for necessities.

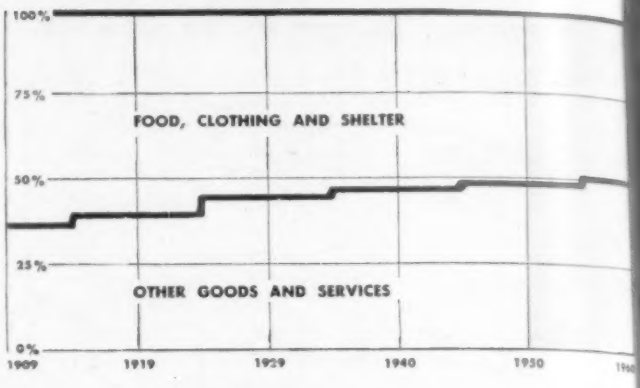
Some of the trends in major markets are summarized in the following sections.

FOOD

Although food is by far the largest item in the consumer budget, its relative importance is declining slowly as living standards rise. People eat the same number of pounds of food they ate in 1909 but the food is better from a nutritional standpoint and easier to prepare. Thus, the trend favors fruits, vegetables and dairy products as against meat, potatoes, and bread.

More and more food is being processed in factories rather than in consumer kitchens. Improved methods of manufacture and distribution have transformed the luxury foods of yesterday into the standard foods of today. New kinds of processed foods — canned, frozen, and dehydrated — are appearing constantly.

STANDARD OF LIVING YARDSTICK: MORE OF THE CONSUMER DOLLAR GOES FOR THE COMFORTS OF MODERN LIFE



CLOTHING

Three long term trends will shape the clothing market in the future: (1) the shift from home and custom to factory fabrication is almost complete;

WHERE CONSUMER DOLLARS GO

(Figures in Billions of Dollars)

	1909	1919	1929	1940	1941	(1944 Prices) 1950	1960
Total Consumer Expenditures	28.8	60.8	80.3	70.6	80.4	116.2	134.2
Food, Liquor, and Tobacco	9.9	22.3	23.7	21.9	25.3	36.2	41.1
Food	7.4	18.8	19.9	16.4	19.0	27.2	30.8
Liquor and Tobacco	2.5	3.5	3.7	5.5	6.3	9.0	10.3
Clothing and Personal Care	4.4	9.8	12.1	9.8	11.5	16.2	18.7
Housing	6.8	10.1	14.4	12.6	13.3	19.3	21.4
Rent a.	5.5	7.9	11.3	9.1	9.7	14.0	15.4
Fuel	1.0	1.5	1.7	1.7	1.8	2.5	2.8
Electricity	0.1	0.3	0.6	0.9	1.0	1.6	1.8
Household Equipment and Operation	2.8	6.2	10.6	8.7	10.3	15.0	17.4
Appliances	0.2	0.4	0.8	1.0	1.3	1.8	2.4
Consumer Transportation	1.6	5.2	8.6	7.3	8.6	12.7	16.4
Autos and Private Planes b.	0.6	3.5	6.0	5.7	6.8	9.6	12.7
Local Bus and Street Car	—	—	0.8	0.7	0.8	1.5	1.5
Intercity Bus	—	—	0.1	0.1	0.2	0.2	0.2
Airlines	—	—	c.	c.	c.	0.1	0.5
Railroads	0.4	0.8	0.6	0.3	0.3	0.4	0.3
Medical Care, Insurance, and Death Expenses	1.1	2.8	4.5	4.7	5.2	7.7	8.7
Recreation	0.9	2.1	3.8	3.3	3.7	5.7	6.9
Radio and Television Sets	0.2	0.7	1.0	0.6	0.8	1.1	1.3
Private Education, Religion, and Welfare	1.2	2.2	2.7	2.3	2.4	3.4	3.7

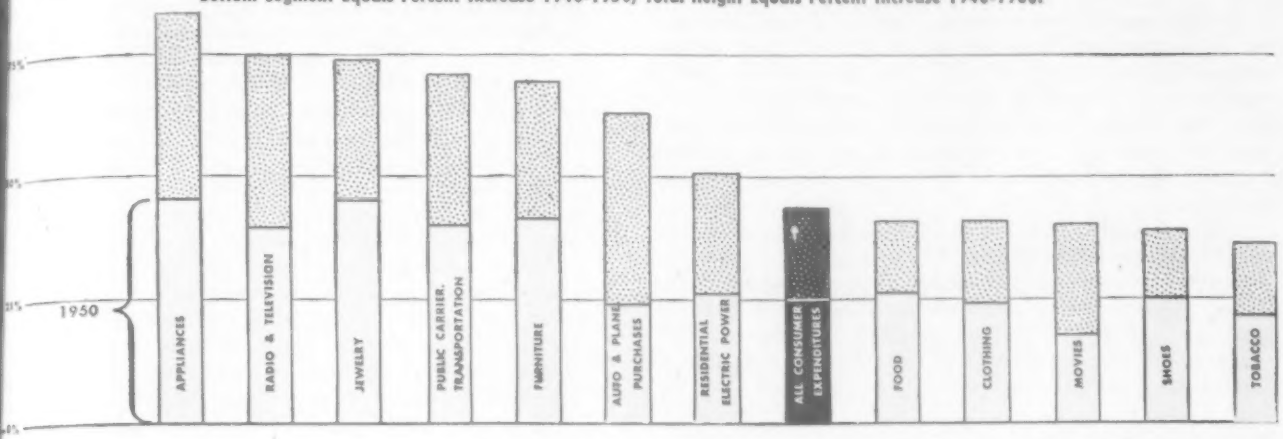
a. Includes Estimated Rent for Owner-Occupied Homes.

b. Includes Original Cost and Operating Expenses.

c. Less than $50 Million.

CONSUMER MARKETS IN 1950 AND 1960: Percent Increase in Sales Over 1940

Bottom Segment Equals Percent Increase 1940-1950; Total Height Equals Percent Increase 1940-1960.



(2) synthetics, chiefly rayon and nylon so far, are replacing cotton, wool, and silk at an accelerating pace; (3) there's greater standardization of styles and a trend to lighter and simpler clothing.

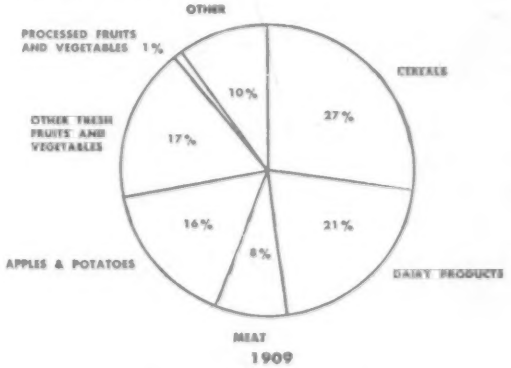
In 1909 consumers spent 14% of their income for clothing but by 1940 the ratio had reclined to 12%. However, this long run decline may be halted or reversed. The migration from farms to cities, the upgrading of incomes, and the growing demand for sports clothing will increase clothing expenditures.

HOUSING

The decline in the relative importance of housing expenditures — from 24% of consumer dollars in 1909 to less than 18% in 1940 — is expected to continue. The reason is that people feel they get more value for their dollars in other things than housing. Nevertheless, the housing market should be much larger in the 1950's than in the 1930's because much of our housing needs to be repaired or replaced.

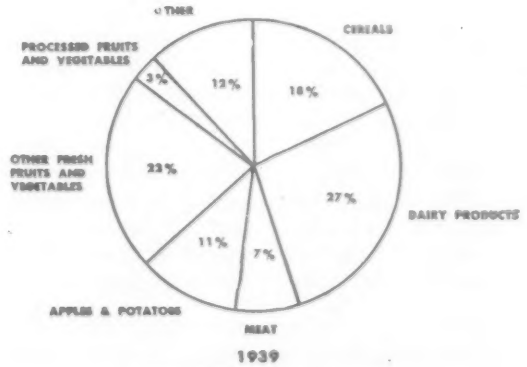
A Census survey in 1940 showed that 16 million of the nation's 37 million dwelling units needed to be replaced or needed major repairs. The 20th Century Fund estimates that the provision of adequate housing for everyone by 1960 would involve building 20 million new units and rehabilitating 5.4 million at a total cost of $115 billion (1944 prices). The Fund also estimates that we will fall 15% short of this goal even with continued high-level employment.

OUR CHANGING DIET: MORE MILK, FRUITS AND VEGETABLES LESS MEAT, POTATOES AND BREAD



1909

1880 POUNDS OF FOOD PER PERSON



1939

1882 POUNDS OF FOOD PER PERSON

HOUSEHOLD EQUIPMENT

More and more of the consumer dollar has gone for household equipment in the past four decades, largely because of the development of labor-saving appliances. The outlook is for a continuation of this trend. New appliances are being developed; and the large number of new houses slated to be built in the next few years, the wartime and postwar boom in the number of families, and the migration to the cities should add to appliance demand. The same factors should brighten the outlook for furniture, rugs, and other household items.

Some appliance markets may be saturated by the 1950's, however. A few years of high production would fill our homes with refrigerators, for example. However, replacement demand would run to 2.7 million units in 1960 and there would be a demand for 1.3 million refrigerators to equip new houses, so the market would still be bigger than in 1941 when 3.6 million were sold. However, new products must be developed if the industry is to keep up the pace it has set in the past.

TRAVEL

In 1916 the average person traveled 490 miles. By 1940 the average had grown to 2,400 miles, chiefly because of the rise of the automobile. The 20th Century Fund expects this growth to continue because as their incomes rise people spend more money traveling.

A good share of the increased spending will go to purchases of cars and planes. The Fund estimates that there will be 36 million cars on the road and 100,000 private planes in the air in 1950. The auto industry would be able to sell 5 million new cars a year after 1950 — 4 million for replacement and a million for population growth.

CAPITAL INVESTMENT

Investment plays a crucial role in our economy for two reasons. It is by plowing back part of our annual output that we are able to provide better machines and equipment to keep productivity rising. But the amount ploughed back varies widely from year to year. This unevenness of capital investment contributes to the instability of production and employment.

Because capital investment involves the purchase of durable goods, it can be postponed almost indefinitely when the outlook for profits darkens. Thus, capital investment plummeted from $18 billion in 1929 to $5 billion in 1933, a drop of 72%, whereas consumer spending fell only about half as fast in the same period.

MORE FOR EQUIPMENT

There has been an important shift in the relationship between construction and equipment, the two major types of investment. Before World War I, construction made up around three-fourths of total investment but the ratio declined to less than half in 1935-39. Part of the decline is, of course, explained by the fact that the depression left us with ample plant capacity but provided an incentive to buy more efficient machines to cut costs. Nevertheless, there is a well-defined trend towards allocating an increasing proportion of investment to equipment rather than to plant construction.

CAPITAL INVESTMENT . . .

A little less than two-thirds of total investment goes into industrial plants and equipment. Housing and other consumer construction (hospitals, schools, churches) averaged 27% of total investment during the interwar period. Housing fell from a peak of $6 billion in 1926 to $4.7 billion in 1929 and $600 million in 1933; and it had recovered only half the 1926 volume by 1940.

While other types of investment follow the ups and downs in general business, investment in housing construction follows a cycle of its own. This housing cycle is determined by factors such as the vacancy rate, the level of rents, and that of construction costs, which may not follow the trend of general business. When a drop in general business activity takes place during a declining phase of the housing cycle, as it did in 1929, the result is a deep and prolonged depression.

Government investment, of which the largest component is highways, has been much more stable than other types but it doesn't swing enough weight to stabilize total investment.

Because of the wide fluctuations in capital investment, it's much more difficult to estimate future capital expenditures than future consumer purchases. In order to make a relatively stable forecast, the 20th Century Fund bases its estimates on the long term trend since 1879, which shows a slight decline in the share of total output going to capital investment. Thus, investment under conditions of stable prosperity in the 1950 decade is estimated at 16% of total output as compared with a ratio of more than 18% in the late 1920's. On this basis, estimated capital expenditures work out to $28 billion for 1950 and $33 billion in 1960. Our ability to maintain high employment and rising living standards will depend in large measure on our ability to invest that much profitably in new machinery and buildings.

CAPITAL NEEDS

Analysis of our capital needs lends little support to the idea prevalent during the 1930's that we had reached economic maturity so that there was no way to invest as much as we had in earlier decades. No one has ever made an estimate of how much it would cost to modernize our industrial plant, which is valued at around $200 billion at prewar prices. If as much as a third of it needs to be replaced or rehabilitated, around $100 billion (current prices) of additional investment will be required.

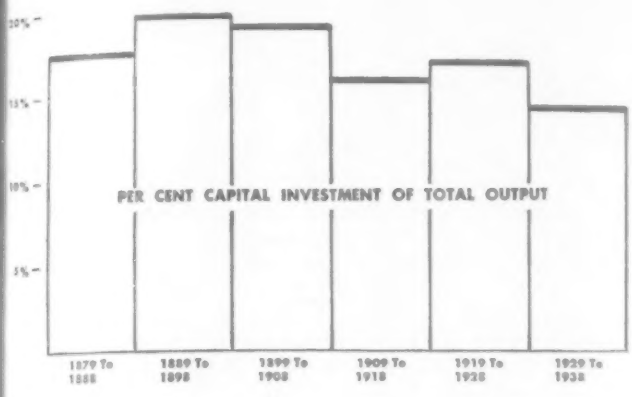
In addition, huge amounts of money need to be invested in housing and public works to raise the serv-

WHERE INVESTMENT DOLLARS GO

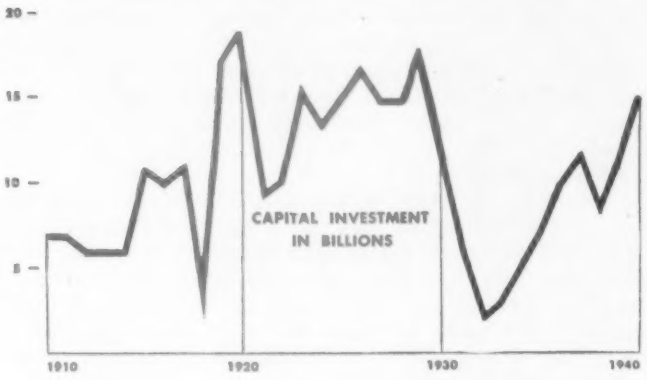
(Figures in Billions of Dollars)

	(Annual Averages)					(1944 Prices)	
	1920-1924	1925-1929	1930-1934	1935-1939	1940-1944	1950	1960
Total Capital Investment	$12,428	$17,186	$8,215	$10,445	$12,340	$27,700	$33,000
All Industries	7,570	10,112	5,272	6,889	8,089	17,800	21,125
Manufacturing	1,996	2,362	1,074	1,610	3,731	4,200	5,025
Food	261	357	194	244		228	273
Textiles	227	212	92	117		175	210
Steel	138	188	110	192		853	1,021
Autos	105	150	78	146		369	441
Chemicals & Petroleum	70	95	68	142		928	1,111
Machinery	—	—	—	28		180	216
Other	510	625	213	409		1,462	1,750
Transportation	1,797	2,303	1,277	1,822	805	4,300	5,100
Commercial	1,196	1,940	777	719	833	1,950	2,300
Utility	693	999	483	422	780	1,500	1,625
Other	1,888	2,508	1,661	2,316	1,940	3,950	4,700
Consumer Construction	3,806	5,557	1,547	2,256	2,912	7,200	8,255
Government Construction	1,052	1,517	1,396	1,299	1,338	2,700	3,620

OVER THE YEARS ABOUT 1/5 OF TOTAL OUTPUT IS PLOWED BACK AS INVESTMENT



BUT THE AMOUNT PLOUGHED BACK VARIES GREATLY FROM GOOD YEARS TO BAD, ACCENTUATING THE SWINGS OF THE BUSINESS CYCLE



ices provided merely to adequate levels. The 20th Century Fund estimates that the cost of a 15 year program to modernize our city streets and rural highways would run to $40 billion. To bring the nation's housing up to minimum standards of health and decency by 1960 would cost $115 billion. To conserve our natural resources and develop our water power would cost $27 billion over a 15 year period.

There seems to be little question that needs exist for all the capital investment we can make for a long time to come. The behavior of investment in the past strongly suggests that the problem is not one of lack of needs but one of finding ways to add to our capital in an orderly fashion. Capital investment has followed the boom and bust route in the past; what is wanted is a high but steady rate of investment.

WARTIME INVESTMENT DEFICIT

Demand for capital goods is stronger right now than ever before, largely because of the backed-up needs arising out of the war. Here is how wartime expenditures for capital goods which can be used in peacetime production compared with expenditures in the last 5 years of both the 1920's and 1930's: (Figures in billions of dollars)

	1925-1929	1935-1939*	1940-1944
Total Capital investment	$86	$65	$49
Industrial	51	43	32
Manufacturing	12	10	14
Metals, chemicals, machinery, petroleum	6	6	11
All Other	6	4	3
Commercial	10	5	3
Railroads	5	3	3
Electric power	5	3	3
Consumer Construction	28	14	12
Public Works	7	8	5

* Adjusted to Wartime Prices

Wartime restrictions held investment in all civilian lines far below what would be spent in prosperous peacetime years. Thus, there was a backlog of investment needs at the end of the war which ran to more than $30 billion, if the 1925-1929 demand can be taken as typical. Whatever the precise size of the backlog, it is clearly great enough, when added to the normal yearly demand for new investment, to keep the heavy goods boom going for some time to come. The test of our ability to stabilize capital investment will come later.

There is also a huge foreign demand for American capital. How far we will go toward meeting this depends largely on whether international political and economic conditions are stable enough to make private foreign investment a good risk.

If we invest abroad in the same proportion we did in the late-1920's, our foreign investments will total $1.6 billion during the year 1950 and $1.5 billion in the year 1960. This will mean a net increase in our foreign holdings of $15 billion during the 1950's, raising the total of such holdings to about $25 billion, as against a total of $10.6 billion in 1940.

To make that much foreign investment pay out, an expanding volume of world trade would be required. Foreign nations would have to get enough dollars not only to pay for goods they bought from us but also to pay interest and dividends on U. S. investments. If our overseas investments increase to $25 billion by 1960, annual interest and dividends owed us will run to almost $1¾ billion.

To pay us that much, foreign nations would have to sell much more in the U. S. than ever before. The 20th Century Fund calculates that imports of $7.3 billion in 1950 and $8.1 billion in 1960 would provide other countries with the dollars they need. Imports ran to $2.5 billion in 1940 so we would have to buy 3 times as much abroad to keep expanding our foreign investments.

With good business, U. S. demand for imported goods should be well above prewar. Rising living standards will widen the market for such consumer items as British tweeds and French perfumes. Moreover, we will need to import more raw materials than ever before because we used up our natural resources at a prodigious pace during the war.

NEW INDUSTRIES

The new methods, materials, and products developed during the war may well have a more profound and lasting effect on future capital requirements than the backed-up demands accumulated in wartime. Here are some of the wartime developments which may have important peacetime applications: new chemical processes and products including synthetic rubber, plastics, synthetic fibers and fabrics; new food products and new methods of food processing; new uses for glass, plywood, and the light metals; tremendous advances in aviation; and new applications of atomic energy and fissionable products in power production and medicine.

Large capital expenditures will be required to push these developments further and adapt them to civilian use. New businesses and perhaps entire new industries will grow up, adding to the demand for capital goods for many years.

THE COST OF GOVERNMENT

To the traditional certainty of death and taxes can be added the certainty that the cost of government will take a much larger share of national income than ever before in peacetime. After the Civil War and again after World War I, federal expenditures moved up to a level four times prewar. And it is already clear that World War II is going to have about the same effect.

In 1940, federal, state, and local governments spent $19 billion, of which a total of $2.2 billion went for national defense, veterans, and interest on the war debt. By 1950, the 20th Century Fund estimates that all governmental units in the U. S. will be spending more than $45 billion. Federal expenditures are estimated at $27.6 billion in that year as against $9 billion in 1940.

Part of the increase is explained by higher postwar prices. Adjusting for price changes would reduce the 1950 figure from $45 billion to $33.5 billion. This is still 80% above the 1940 level. Increased expenditures for public works, social insurance, and schools explain another small part of the rise.

But costs arising out of the war are by far the most important factor. Military and veterans' expenditures and interest on the war-swollen national debt will add up to over $17 billion in 1950. This is only 10% less than total government expenditures in 1940.

The only major category of government expense which would be lower in 1950 is welfare. With high-level employment and more social insurance, relief and other welfare costs should run to $2.5 billion in 1950 as against $3 billion in 1941.

The following paragraphs describe important trends in the major items of government expense.

MILITARY

The 20th Century Fund assumes that we will maintain an armed strength of 2 million men (including trainees) and that it will cost $3,300 to equip and maintain each man, so total military expenditures will run to $6.6 billion. But even if we decide to maintain a smaller armed strength, the total cost might easily be at least $6.6 billion because the present per serviceman cost of over $6,000 a year may not decline.

AND GOVERNMENT . . .

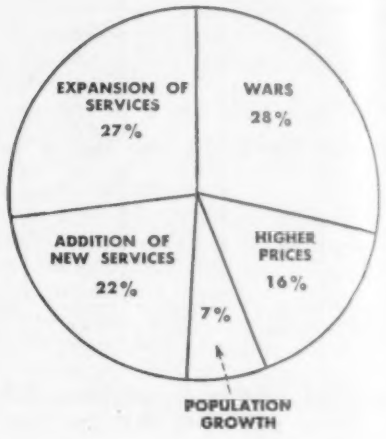
VETERANS

It will cost at least $2.9 billion to take care of veterans in 1950 even if benefits are not increased. That's 5 times the 1941 cost. Pensions for World War I veterans rose steadily from $116 million in 1924 to over $300 million in 1945. That rise will continue for another 20 years. By far the largest expense will be for World War II pensions which are already costing $900 million. Disability and death benefits will cost about $1¾ billion in 1950; hospitalization will add another $250 million; and insurance $150 million.

SOCIAL SECURITY

Future expenditures for social security will depend on whether steps are taken to extend coverage and liberalize benefits. Over 60 million people are now covered so the cost is certain to increase rapidly as more of them begin to draw payments. With high-level employment in 1950, estimated old age and unemployment benefits under the present system would run to over $5 billion. Expansion of benefits, as recommended by the Social Security Board, would raise the cost to over $9 billion.

WHY THE COST OF GOVERNMENT HAS INCREASED. The $25.6 billion increase in cost from 1913 to 1941 was due to:



PUBLIC WORKS

Even an economy-minded Congress is almost certain to go along with expenditures for highways, airports, waterways, flood control and conservation. Thus, an increase in expenditures for transportation and natural resources from less than $2.5 billion to over $5 billion in 1950 seems probable.

SCHOOLS

Education ranks third among all government expenditures. In 1941 we spent almost $2.5 billion—10% of all government dollars—on schools. Teachers' salaries account for almost three-quarters of the total cost so the trend towards higher salaries will boost the nation's bill for education.

WHERE TAX DOLLARS GO

(Figures in Billions of Dollars)

				(1944 Prices)	
	1913	1932	1941	1950	1960
All Government Expenditures	2.5	12.4	23.1	45.5	50.7
Federal	0.7	4.3	12.9	27.6	28.6
State	0.2	1.8	3.6	7.0	9.3
Local	1.6	6.3	6.6	10.9	12.8
Military	0.27	0.7	6.1	6.6	6.6
Veterans	0.18	0.8	0.6	2.9	3.2
Interest	0.15	1.3	1.7	7.9	8.1
Social Insurance	—	0.2	1.9	7.7	8.7
Welfare & Health	0.31	1.5	4.1	4.0	4.1
Education	0.65	2.5	2.7	3.7	4.3
Public Works	a.	a.	a.	5.6	7.1
Transportation	0.40	1.9	2.0	1.8	2.7
Natural Resources	0.03	0.6	1.4	1.2	1.1
Police & Fire	0.19	0.7	0.7	1.0	1.1
Other	0.40	2.4	2.0	3.0	3.6

a. Included in other groups.

ATURAL RESOURCES

The war left the U. S. with a depleted supply of ost natural resources, and with critical shortages f some of the most essential minerals. Nevertheless, ck of natural resources should not be a limiting ctor on our productive capacity. With relatively ee access to world markets, we should be able to et all the raw materials we need. And, even if we ere denied access to world markets, we could use ur low-grade reserves and develop substitutes with- ut causing a prohibitive reduction in our living tandards, though everyone would feel the effects in ne way or another.

The U. S. economy consumes about a billion and half tons of raw materials each year, or about 11.5 ons per person. Of this 3.5 tons are coal, 1.5 tons re petroleum, and iron and copper ore each con- ribute about a half a ton. In 1939 the value of un- efined minerals output was $4.2 billion and 2% of ll workers were engaged in mining or lumbering.

UTURE REQUIREMENTS

The level of industrial production projected by the 20th Century Fund would raise minerals requirements third above 1940 by the year 1950 and 50% above 1940 a decade later. Here is how natural resources requirements in the 1950 decade would compare with 1940 and the wartime peak: (Index numbers, 1940 equals 100)

	Wartime Peak	*1950*	*1960*
All minerals	138	133	151
Metals	157	117	126
Fuels	130	141	164
Other	141	128	142
Lumber	126	93	76
Electric Power	159	173	224
Manufactured Gas	120	94	75

The capacity of our supplies of natural resources o support future levels of output cannot be deter- mined with any great accuracy. It will depend on the size of our reserves and on our ability to use supplies more economically and develop substitutes.

H THE OURCES AILABLE . . .

Because there is no way to measure these factors with any degree of precision, all estimates of the number of year's supply are subject to wide errors. However, such estimates are useful in directing attention at those resources where every effort should be exerted to develop new supplies, substitutes, and more economical methods of use.

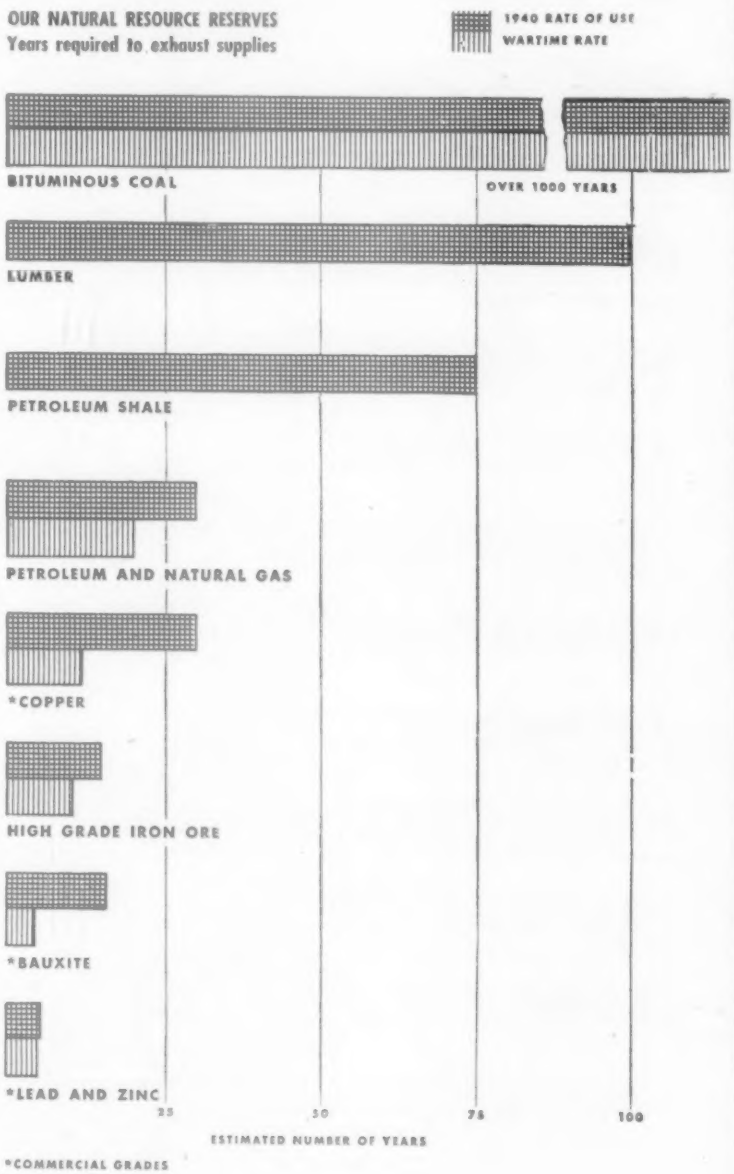
BIGGEST PROBLEMS: LEAD AND ZINC

Commercial grades of zinc, lead, and bauxite will be exhausted before 1960 even if the rate of use is cut to half the wartime rate. Supplies of petroleum and natural gas — which furnish 40% of our energy — will last longer than 20 years but their partial depletion will raise many technical and economic problems long before that time. Possible exhaustion of high-grade deposits of such minerals as iron and copper in the foreseeable future will stimulate development of processes to use low-grade deposits.

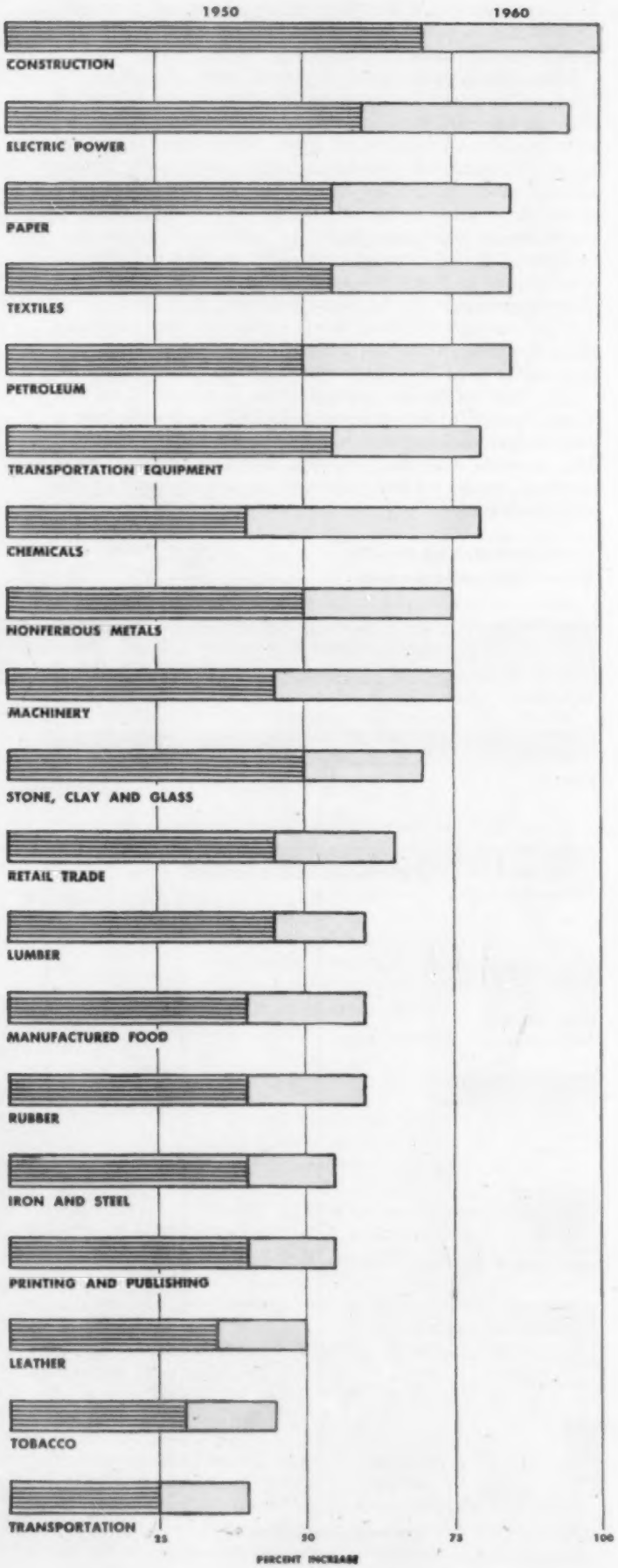
We have been discovering more and more ways to stretch our supplies of natural resources, however. In the case of tin, the electroplating process saves 50% of the tin used in tinplate production. The electric power industry uses less than 40% as much coal per kwh now as in 1920. The development of new materials and new ways of using old materials also expands our resource capacity.

Our bituminous coal reserves are adequate for over a thousand years even at the wartime rate of use, though production costs might rise substantially as inferior coal beds were used. After that, there are huge deposits of sub-bituminous coal and lignite which could carry us along for another thousand years. In comparison, maximum petroleum reserves are minute, adequate only for about 30 years consumption at the current rate. That is why the experts are trying to find ways to produce oil from coal cheaply enough to be commercially feasible.

Even though we have been using up lumber faster than it grows, there is little doubt that enough will be available in the future to meet at least minimum needs. Annual timber growth runs to about 32 billion board feet. But we cut over 40 billion board feet a year before the war and lost another 6 billion through fire, insects, and disease. An adequate conservation program could increase annual growth enough to offset this depletion.



PRODUCTION PROSPECTS: Estimated Percentage Increase in Industrial Activity Over 1940



INDUSTRIAL CAPACITY

At the end of World War II U. S. industry found itself with surplus capacity in some lines and serious deficiencies in others. There was more than enough aircraft, machine tool, and synthetic rubber capacity but not nearly enough sheet steel, copper, or electrical machinery capacity to meet pent-up demands.

War experience showed, however, that industrial capacity can be expanded enormously in a few years, given the need and the funds. Thus lack of industrial capacity should not prove a bottleneck to meeting the demands of consumers in the 1950 decade.

A rough estimate places our total investment in industrial facilities (manufacturing, mining, transportation, and distribution) at $200 billion. Just how much capacity industry as a whole, or any given industry, has is impossible to measure.

Capacity is a most elusive concept. In a technical sense, the capacity of an industry is the combined production of all its plants working 24 hours a day, 365 days a year, less an allowance for repairs, breakdowns, and other technical factors. Actual capacity is far less, however. Some facilities are obsolete or high-cost. Supplies of raw materials and components may be insufficient to keep assembly plants running full-steam. Moreover, demand for many products isn't great enough to support round-the-clock production.

PLENTY OF CAPACITY

During the past quarter century, however, experience shows that we have had more than enough overall capacity, and more than enough capacity in almost every industry, to meet all demands. An extensive study showed that even in 1929 only the steel and machine tool industries were definitely operating at capacity.

The growth of productivity as old machines are replaced with new and more efficient ones and as new techniques are developed is one of the main reasons why industrial capacity more than keeps pace with markets. The depression of the 1930's led to a net retirement of about 5% of total manufacturing facilities but manufacturing plants in 1939 could have turned out a quarter more than in 1929 because productivity was a third higher.

Whenever an industry's output begins to approach technical capacity, it becomes profitable to purchase new and more efficient equipment to replace or supplement existing machines so that a certain amount of excess capacity seems to be inevitable in a free enterprise system.

Estimates of the level of industrial production in different lines under conditions of high-level employment during the 1950 decade are shown in the chart. They assume that past trends will continue so that they give only a rough idea of what would happen to output in each industry. Unpredictable shifts of consumer demand or new product developments might cause a big change in the pattern of industrial production. Such estimates are, nevertheless, useful in that they provide a clue to lines where the largest increases may take place.

None of the projected increases are so large as to tax our ability to provide enough capacity. This is not to say that there will be no bottlenecks because of lack of capacity for certain components, for instance. However, we should be able to make good in short order any deficiencies of that sort that may develop.

DEMANDS VERSUS NEEDS

Despite the substantial increase in living standards which would be possible with high-level production and employment in the 1950 decade, many U. S. consumers will be unable to buy enough of life's necessities to maintain themselves at a health and decency level. Almost 30% of all families would receive less than $1,000 a year cash income and one-third of this group would receive less than $500.

The 20th Century Fund asked a series of experts to estimate the quantities of food, clothing, housing, medical care, and other things needed to provide a standard of living at a minimum health and decency level. The experts also figured out how much it would cost to bring everyone expected to be below that standard in 1950 and 1960 up to the calculated level. In other words, the estimates show the cost of establishing a "floor" for consumption without disturbing the spending patterns of those who received more than enough income to satisfy the calculated minimum needs.

ESTIMATES OF NEEDS

Any estimate of "needs" must rest upon someone's opinion as to what constitutes "health and decency" in this day and age. In the case of food, the nutritional requirements of a minimum health and decency standard can be determined accurately. In other fields, such as housing and education, even the experts would disagree over what constitutes a minimum standard.

However, what is important is not the precise size of the estimates but their general magnitudes. The conclusion that we would have to spend about 50% more on medical care than we are likely to in 1950 is important even if the experts' appraisals of the deficit range from as high as 60% to as low as 40%.

To fill total needs calculated in this manner would require production of $200 billion of goods and services in 1950 or 13% more than the $177 billion which would be turned out with high-level production and employment. In 1960, estimated production would fall short of needs by 8%. Food accounts for the biggest share of the deficit but needs outrun demand by important margins in housing, medical care, education, and social security.

MEET

MOST ALL

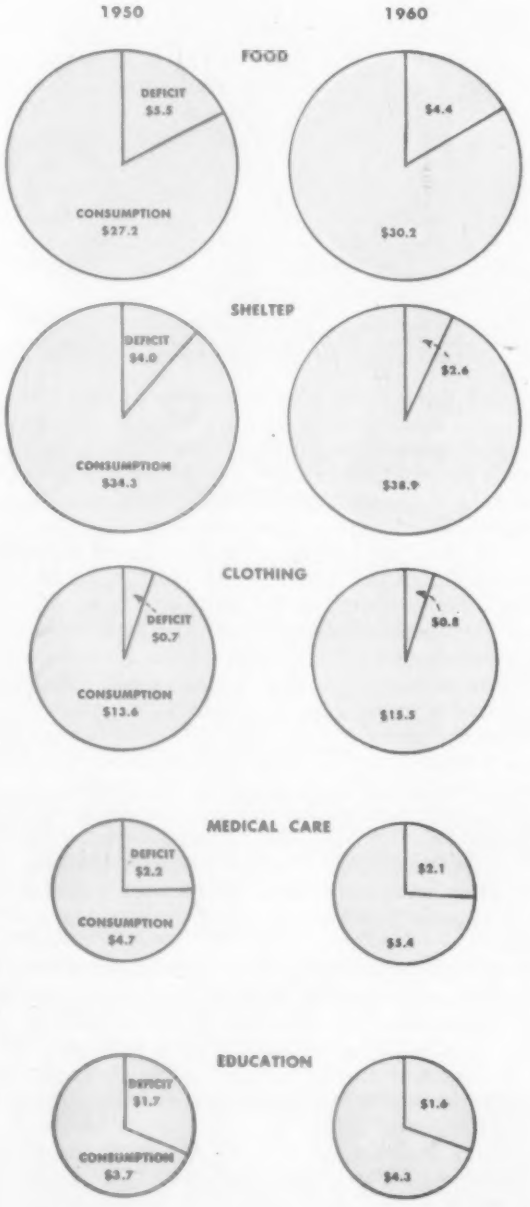
R NEEDS

To provide nutritionally adequate moderate-cost meals for those unable to afford them would add $5.5 billion to the $27.2 billion that would actually be spent on food in 1950. This assumes no change in diets of those with adequate incomes despite the fact that many people in those groups do not eat what they should. If we all ate what we needed, we would consume twice as many fresh vegetables as in 1940, half again as much milk, more fruits and tomatoes; and we would eat smaller quantities of sugar, sirups, fats, and oils. This better diet would cost us less than we will actually spend for food in 1950.

So large a portion of our existing housing is unsatisfactory by any reasonable standards that it would take 10-15 years to provide everyone with adequate housing. One of the reasons why we don't have adequate housing is that many consumers cannot afford to pay enough rent to finance it. Estimated expenditures in 1950 for rent (including the estimated rental value of owner-occupied homes) would run to $14 billion as against an estimated need of $16.4 billion.

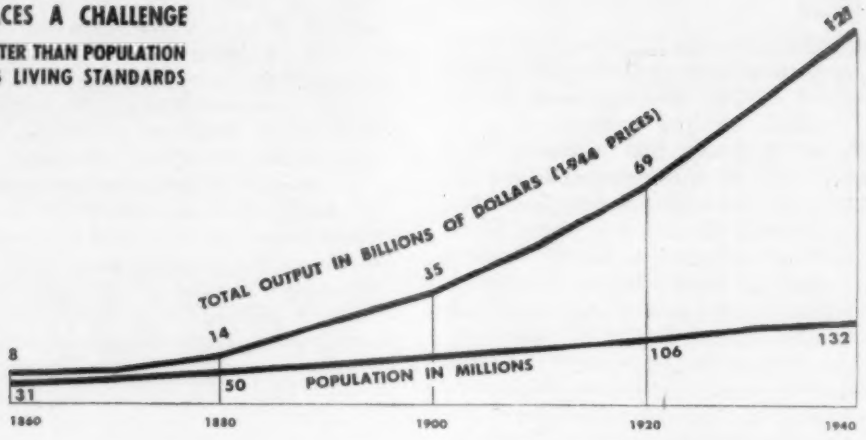
Vast advances in medicine have gone far toward eliminating many diseases and have brought about a steady improvement in the standard of health. However, large numbers of people in the lower income groups cannot afford adequate medical care. Moreover, to supply good medical care for everyone under the traditional fee-for-service basis would cost several times more than consumers have ever spent for medical services even in prosperous years. Development of an effective form of group medicine, however, would make it possible to provide adequate care at a great saving over present costs, according to the 20th Century Fund.

HOW CONSUMPTION WOULD COMPARE WITH TOTAL NEEDS
(Figures in billions of dollars)



THE U. S. ECONOMY FACES A CHALLENGE

PRODUCTION HAS GROWN FASTER THAN POPULATION GIVING PROMISE OF RISING LIVING STANDARDS



The major conclusion of the 20th Century Fund's survey of America's needs and resources is that we have reached a point where we can provide everyone with a decent living and most people with a living which, by any standards other than our own, is positively luxurious. With high-level employment, it would take only a 13% increase in total output in 1950, and an 8% increase in 1960, to lift everyone to a minimum health and decency standard of living.

We have more than enough industrial and agricultural capacity to support that much of an increase in total production. Lack of natural resources should not be a bottleneck, for with world trade on any sort of a reasonable basis we will be able to get all the raw materials we need.

The only limiting factor is the capacity of our labor force to produce. The 20th Century Fund assumes that productivity will advance at the average rate actually achieved during the past 9 decades (18%). But there is no technical reason why we cannot achieve an increase of more than 30%. That would make possible enough production to meet our minimum needs.

The U. S. economy has exhibited two dominant characteristics in the past century. Our productive capacity has expanded at a rate never approached elsewhere. But our economy has also been highly unstable. Our problem is to make the most of our unparalleled technological and productive know-how while minimizing the swings of the business cycle.

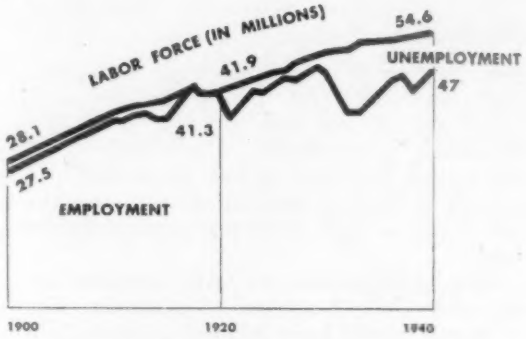
If we can meet that challenge, we can eliminate the specter of want and move on toward constantly rising living standards for everyone. Never before in history has a nation been so close to abolishing poverty and meeting the material demands of its citizens

This is not to say that solving the problem of maintaining stable and expanding production would solve all our economic, social, and political problems. Nor is it to say that a solution of the problem of keeping our economic machine running on an even keel is at hand.

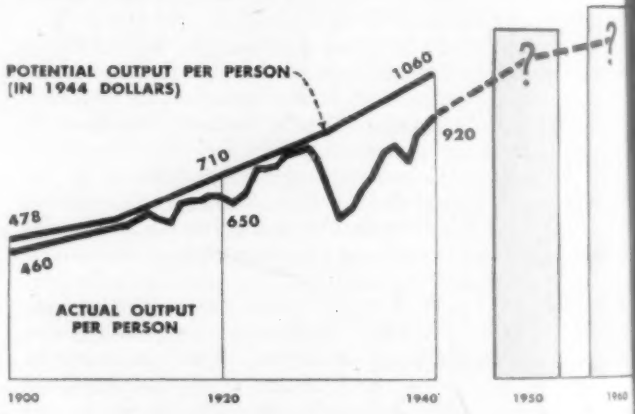
In the first place, the U. S. would not be a utopia even if we achieved the kind of high employment and production the 20th Century Fund is talking about. Many perplexing problems of how to best distribute our production would remain. Then there are a host of social and political problems which would still tax our efforts and ingenuity. Finally, there is the all-important question of how to maintain world peace.

Most people would agree that the problem of maintaining high employment and rising living standards is still far from solution. Our ability to mobilize and direct our economic resources so as to keep our economy running on an even keel has lagged behind our ability to solve technical production problems. Each businessman, each worker, and each consumer must somehow learn to act differently in many ways than he has in the past if we are to solve our number one economic problem.

BUT THE GROWTH HAS FOLLOWED THE BOOM AND BUST ROUTE INVOLVING LONG PERIODS OF MASS UNEMPLOYMENT



CAN THE ECONOMY PROVIDE STEADY EMPLOYMENT AND RISING LIVING STANDARDS?



Just what changes in our economic life will be necessary no one knows. On our ability to find out these things and put them into practice in the next few years depends our success in meeting the challenge which the 20th Century Fund's study underlines. That challenge is that we have within our grasp the ability to eliminate actual want from the U. S. and to provide more and more things for better living for everyone.

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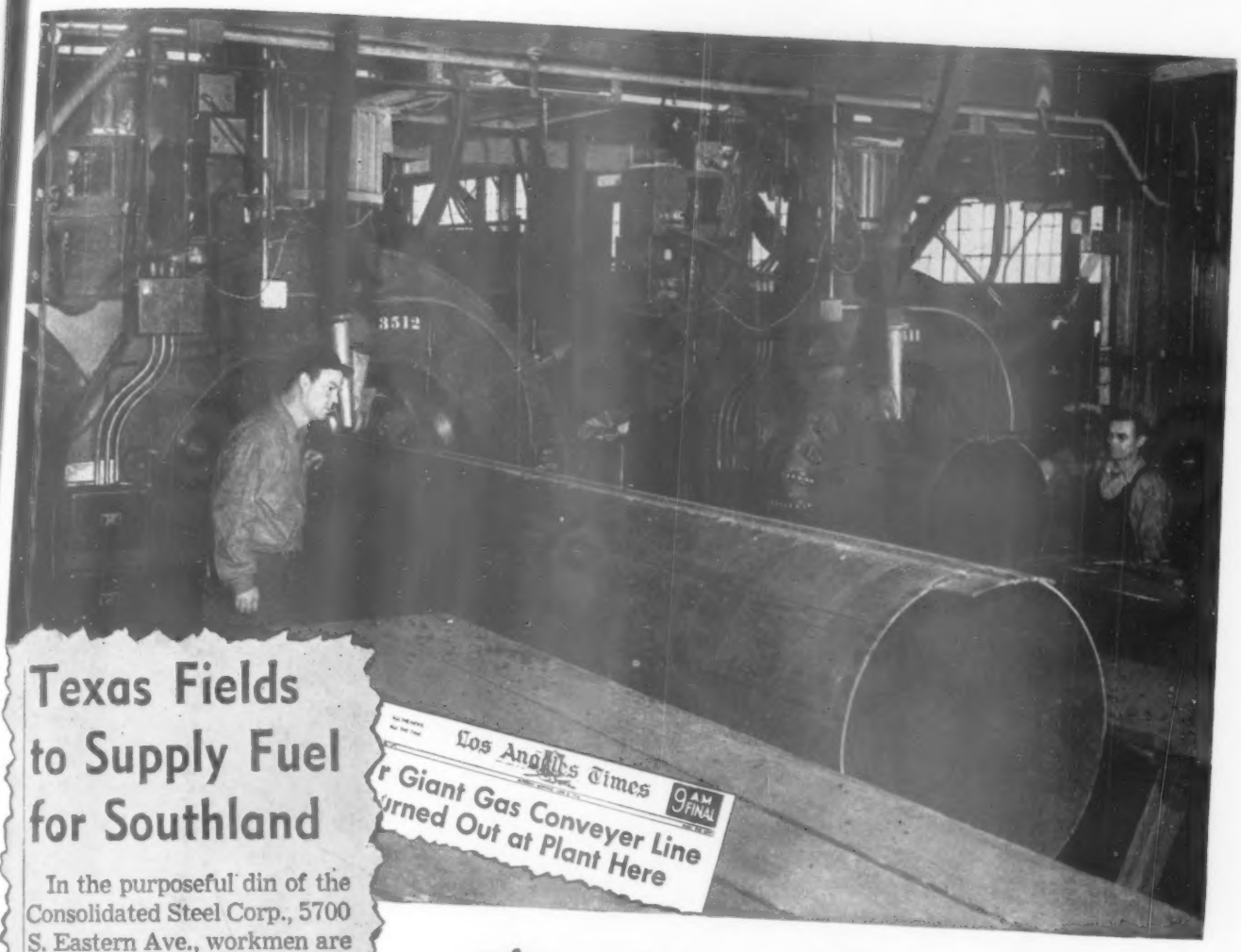

Texas Fields to Supply Fuel for Southland

In the purposeful din of the Consolidated Steel Corp., 5700 S. Eastern Ave., workmen are shaping the future of Los Angeles for another generation.

Every four and a quarter minutes, they are turning out a 60-foot section of high strength pipe 30 inches in diameter, through which the gas needed for Los Angeles homes and industry will flow from the oil fields of Texas.

New Process Used

Charles W. Crawford, vice-president of Consolidated Steel, said the pipe is being fabricated by a process new to the West Coast in that it embodies continuous welding of the longitudinal seams and hydraulic expansion of the welded pipe sections.

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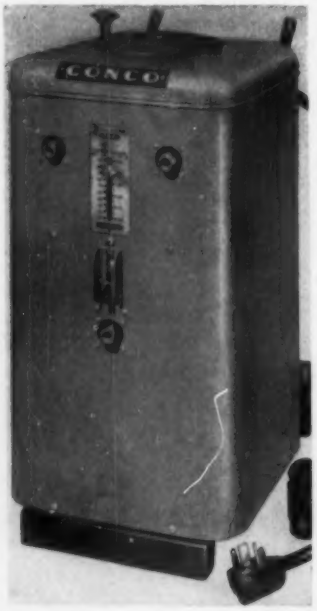


Conco portable arc welder for garages, service stations and repair shops

Portable Arc Welder

OUTSTANDING feature of the new Conco portable a-c welder is a stepless current regulator to allow any current between 20 and 150 amp. The welder plugs into a 230-volt, 60-cycle outlet and measures 18¼ by 26 by 38½ in. It meets all REA, NEMA and Underwriters' Laboratories requirements and may be used for cutting, brazing, welding or soldering, states manufacturer. CONCO ENGINEERING WORKS, Mendota, Ill.

* *

Low-Alloy Electrode

FOR d-c, reverse-polarity welding in all positions of low alloy cast steel or low-alloy, high tensile rolled steels, the new AP-MO electrode meets the requirements of AWS-ASTM tentative specification E-7010. It is available in three diameters: ⅛, 5/32, and 3/16 in. WESTINGHOUSE ELECTRIC CORP., P.O., Box 1017, Pittsburgh 30.

* *

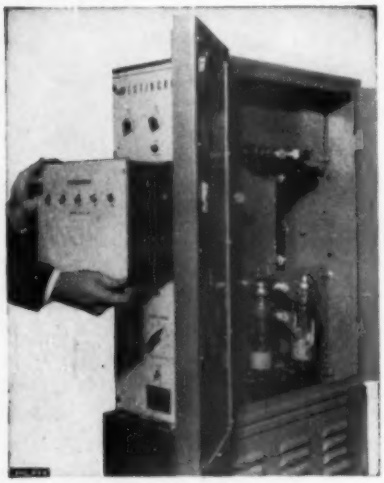
Electrode Package

"ROD-PAK" is a new set of packaged electrodes for plant maintenance and small repair shops. Available in 5 or 10 lb quantities, each package contains 17 types of electrodes in popular sizes. Types and sizes of the rods are printed on both ends of the package for quick identification. MARQUETTE MFG. CO., INC., Minneapolis 14, Minn.

Packaged Controls

"WELD-O-TIMER" designates a line of non-synchronous, packaged controls that are said to make it possible to effect hundreds of combinations for sequencing and timing in a-c resistance welding. There are only four factory-wired subassemblies and two supplementary subassemblies. Made in two frame sizes, 1200 and 600, these units may be mounted to the side of the welder, on the floor or at any convenient place away from the welder (with adjustment controls at the welder).

Voltage regulator tubes are incorporated in the timing circuits to give more accurate timing. A transparent access door in the 1200 frame size and a metal access door in the 600 size protect control settings against unauthorized tampering. WESTINGHOUSE ELECTRIC CORP., P.O. Box 1017, Pittsburgh 30.



"Weld-O-Timer," a packaged control in 600 and 1200 frame sizes

* *

Hard-Facing Electrode

A NEW hard-facing electrode, "Hardalloy," is recommended as a repair overlay for building-up tractor parts, roll crushers and other heavy equipment. Although the deposited weld metal has a high hardness (Rockwell C-59.0), tests have shown no cracking or spalling after repeated impact. The low hydrogen content of the coating is said to minimize underbead cracking in the parent metal when hardenable steels are being reclaimed . . . "Hardalloy" produces a non-porous, uniform deposit that permits multiple-layer build up without cross checking or cracking, states manufacturer. It operates on direct current, reverse polarity. THE MCKAY CO., 1005 Liberty Ave., Pittsburgh 22.

Model UP induction heater for preheating large pipe joints

Induction Preheaters

INDIVIDUAL portable induction-heating units of 10-kva each are offered for preheating and normalizing welds and other applications. These units may be used separately or stacked to form groups of two and three units with capacities of 20 and 30 kva, respectively. The 30-kva group is capable of preheating a 10-in. pipe joint to 1,300 F in two hours.

The model UP induction heater is useful in a limited space and crowded conditions as it can be kept close to the work. Variations in heating current and voltage output are readily obtained by a built-in selector switch. Controlling pyrometers and program controllers can be readily plugged into the two polarized receptacles for the recording of job temperatures and heat cycles. Polarized receptacles are also provided for the interconnection of the heater into groups and for the power supply.

The heater has many other uses such as testing current transformers, supplying "phantom loads" for testing relays on power systems, thawing water systems, resistance heating for brazing, soldering, shrink-fitting, straightening, etc. ELECTRIC ARC, INC., 156 Jelliff Ave., Newark 8, N.J.

* *

Electrode for Cast Iron

AN all-position electrode (W-2075), composed of pure nickel core wire and an extruded black covering is recommended for making machinable welds in cast iron. This electrode is said to eliminate the hard zone found in welds made with mild-steel electrodes on cast iron and to produce a close color match after machining.

The deposits, though convex, are smooth, uniform, and well bonded to the cast material. Arc-stabilizing ingredients used in the coating enable this electrode to be used on either a-c or d-c reverse polarity. GENERAL ELECTRIC CO., Schenectady 5, N. Y.

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UNITED STATES STEEL

"Panoram" chipping goggles have air-conditioned plastic eyecups and frames

Chipping Goggles

A-O "PANORAM" is the name of lightweight plastic safety goggles with air-conditioned eyecups to reduce lens fogging. It provides wide angle vision as well as a large area of protection on such jobs as chipping, grinding, babbitting and machining operations. This goggle may be worn over most types of prescription glasses. Either clear or green lenses and frames are available. AMERICAN OPTICAL CO., Southbridge, Mass.

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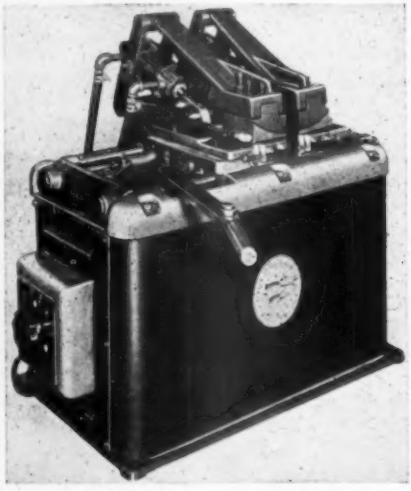

10-kva bench-type butt welder for operation at 220 or 440 volts

Bench Butt Welder

OUTSTANDING features of the new Banner 10-kva butt welder are: eight ranges of heat, round steel guides for movable platens, built-in tap switch, water-cooled head and transformer. This is a bench-type welder, compact in size and operated from a foot switch connected to a four-way solenoid air valve. Current is automatically shut off by an adjustable limit switch. BANNER PRODUCTS CO., 4960 N. 29th St., Milwaukee 9.

Electrode for Cast Iron

MADE to operate on either alternating or direct current, a new all-position electrode called "Nicast" may be used to repair or build up broken iron castings or correct machining errors. It can also be employed to weld cast iron to steel. Strong, non-porous welds are produced on cast iron, machinable in both the weld and fusion zones. Most applications require no preheating or postheating. "Nicast" is available in $\frac{1}{8}$ and $\frac{5}{32}$ in. diameters. HARNISCHFEGER CORP., WELDING DIVISION, Milwaukee 14.

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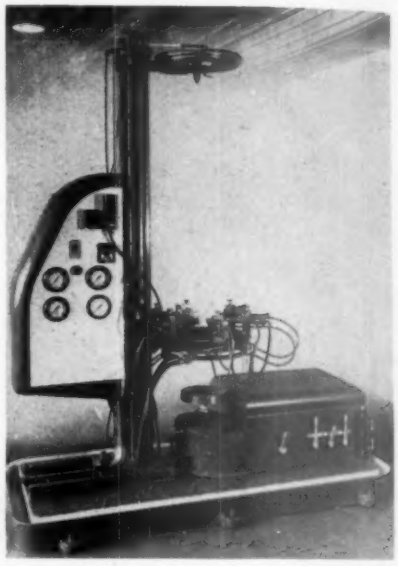

Denver flame-hardener with adjustable heads and variable speeds

Flame-Hardener

MODEL 20 "Denver" flame-hardener is suitable for hardening cylindrical workpieces by any of three methods: progressive, where the work remains stationary and the flame head moves; spinning, where the work turns rapidly and the flame head remains stationary; or a combination method in which the work rotates and the flame head travels upwards, followed by a water quench. The flame head may also be mounted for vertical or horizontal travel in a straight line. This process is suitable for hardening cast or rolled steels with a carbon content of 0.35% or greater, also gray cast irons. STEARNS-ROGER MFG. CO., Denver 2, Colo.

* *

Tension Clamp

A SPRING-TENSION clamp that can be used for light welding or other sheet metal fabrication may be applied with either pliers or gun in a time said to average about one tenth that needed to apply screw-type clamps. The new spring-tension clamp may be adjusted to secure any pressure up to 70 psi. Units are available in three standard sizes and may be ordered in special dimensions to fit job requirements. AIRCRAFT TOOLS, INC. 2306 E. 38th St., Los Angeles 11.

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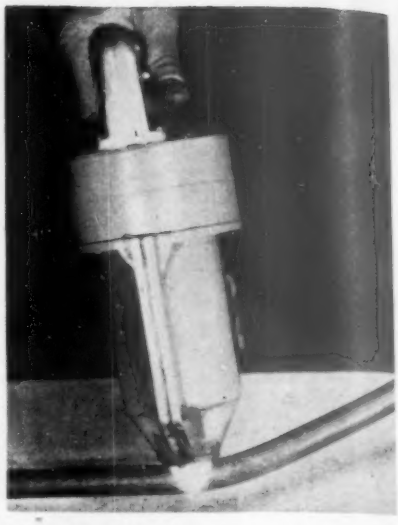

Portable induction-heat gun for rapid brazing, hardening or soldering

Induction Heat Gun

THE "Tocco" induction-heat gun is said to operate faster than either a soldering iron or an oxy-acetylene torch for such applications as hardening, soft soldering, brazing, annealing and heating for forging. The 8-lb unit may be used with the bare hand since no high-voltage hazards exist. To operate, the nose of the gun is placed against the piece to be heated and the trigger is pulled. The latter action connects the gun to a 9,600 or 10,000 cycle generator—the required power source. Ferrous or non-ferrous metals may both be treated with this induction-heating process. The OHIO CRANKSHAFT CO., Tocco Division, 3800 Harvard Ave., Cleveland 1.

* *

Rust Remover

"CORODEX" is the name of a new liquid rust remover that is said to be capable of removing a rust coating up to ¼-in. thick. Applied with a paint brush or cotton swab, it reaches pin-point spots, pits, crevices, cracks or corners on any surface, states manufacturer. It is non-explosive, non-inflammable and requires no rubbing. Articles may be wiped clean with a dry cloth, leaving a rust-free surface.

This new product is available in 12 oz and quart bottles, gallon containers and fifty-five gallon drums. Companions to "CorOdex" are rust preventatives "Corocide and Corodoil." ALLIED PRODUCTS CO., Dept. 199, 1133 W. Newport St., Chicago 13.

* *

Sheet-Metal Electrode

"SW-16" is a high-speed, heavy-coated, all-position electrode for welding light-gauge mild steel sheets. It produces a bead contour that requires little finish grinding and is said to minimize bead sagging and burning through. SW-16 has a wide variety of applications in the automotive, refrigeration, air-conditioning and similar fields where a large amount of sheet metal fabrication is done. A. O. SMITH CORP., Milwaukee.

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Building Construction Welding	10 Pages
Cast Iron Welding	25 Pages
Copper Alloy Welding	13 Pages
Cylinder Heads	5 Pages
Electrodes	17 Pages
Electronic Controls	4 Pages
Eye Protection	4 Pages
Flame Cutting	24 Pages
Flame Hardening	7 Pages
Flame Machining	4 Pages
Flame Shrinking	2 Pages
Farm Welding	7 Pages
Gas System Pipe Lines	6 Pages
Grinding Welds	3 Pages
Hard Facing	10 Pages
Jigs and Fixtures	5 Pages
Job Shop	11 Pages
Locomotive Repair	14 Pages
Magnetic Inspection	6 Pages
Metal Spraying	16 Pages
Metallurgy	21 Pages
Nickel Welding	22 Pages
Oxy Acetylene Welding	18 Pages
Pipe Welding	27 Pages
Qualification Procedures	23 Pages
Railroad Maintenance	20 Pages
Resistance Welding	32 Pages
Sheet Metal Welding	8 Pages
Ship Welding	17 Pages
Structural Welding	16 Pages
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CUTS COSTS

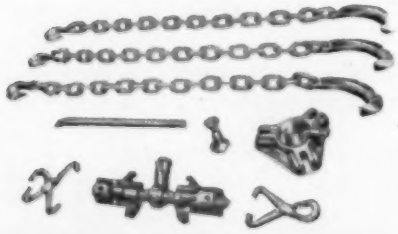
—on Pulling, Pushing, Spreading, Bending, Clamping, Holding and Lifting Jobs

• There's hardly a spot in any busy plant or in the field where you won't find many uses for a "Util-A-Tool" Set—on production installation, maintenance and repair operations.

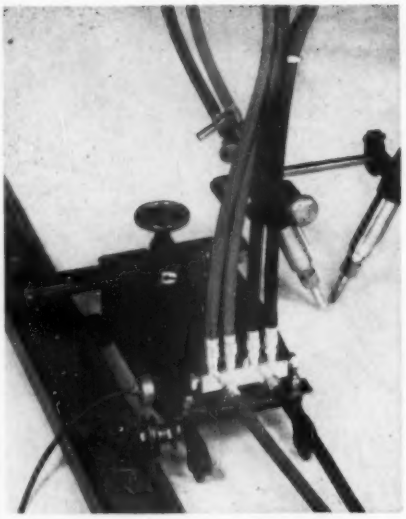
Here are a few of the many jobs a Simplex "Util-A-Tool" handles with cost-cutting speed and efficiency: (1) Clamping and holding parts for welding or assembly, (2) Pulling pinions, bushings, wheels, and gears, (3) Lifting or lowering heavy machinery for installation, leveling or maintenance, (4) Serving as a handy beam clamp for chain hoists with the use of sky hooks.

Time and labor savings on a single job often save more than the full cost of a "Util-A-Tool" Set. Now available for immediate delivery through distributors everywhere. Write for Bulletin P & P-46.

"THE TOOL OF A THOUSAND USES"



TEMPLETON, KENLY & CO.
1000 South Central Ave., Chicago 44, Ill.



Attachment for cutting long or warped plates. It eliminates hand finishing

Trackless Cutting Attachment

A NEW attachment for the "V-10" Gaso cutting machine is said to simplify the cutting of long or warped surfaces. With the necessary guiding devices attached, the machine runs alongside any channel or angle (preferably a standard 4-in. structural channel), eliminating the need for special tracks. Since channels are available in lengths up to 50 ft, a 48-ft cut can be made without tracks. The need for torch adjustments to follow the contours of the work is eliminated because the machine runs on the plate being cut and follows its contours automatically. Neither piercing for starting or hand finishing of ends are required, states manufacturer. GASO EQUIPMENT Co., 3253 N. Kedzie Ave., Chicago 18.

* *

Electrode for Cast Iron

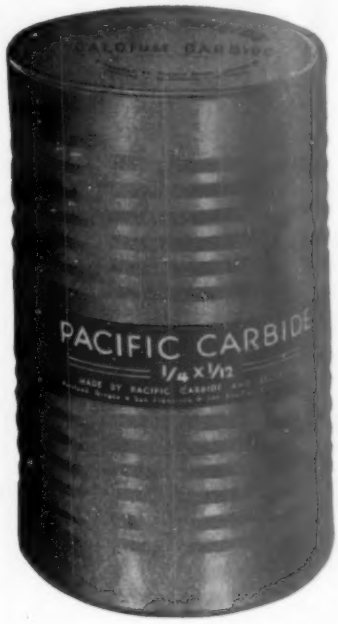
AIRCO No. 375, a high-nickel core wire with a heavy extruded coating, has possible application wherever welding is to be done on cast iron. It is particularly applicable in the automotive field for production-line repair work and for use on all castings requiring machinable welds. The high nickel content causes the electrode to flow well, giving a sound and machinable weld.

This all-position electrode (a-c/d-c) permits multiple-pass welds to be made without danger of cracking. It is available in $\frac{5}{32}$ and $\frac{1}{8}$ in. diameters. AIR REDUCTION SALES Co., 60 E. 42nd St., New York City 17.

* *

Hardness Tester

MODEL LR "Tukon" tester applies loads of from 25 to 50,000 grams to test metal hardness with either a Knoop or diamond-pyramid indenter of the Vickers type. The Knoop indenter is used for tests from 25 grams to 3,600 or 5,000 grams, and the 136-deg diamond pyramid indenter is used for tests ranging from 25 to 50,000 grams. WILSON MECHANICAL INSTRUMENT Co., INC., 230 Park Ave., New York City 17.



Pacific Carbide is generating acetylene in 12 countries

A tested carbide . .
meeting International and
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generating acetylene
in 12 countries.
Standard sizes
in 100-lb. and 500-lb.
drums.
Location of our plant
at Portland, Oregon
permits low-cost
delivery to all
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(Subsidiary of Stuart Oxygen Co.)
351 California Street
SAN FRANCISCO 4

IMPORTANT: These companies are not connected with any other producers of Carbide.

Power grinder may be used with either a cup grinding wheel or a wire brush

Power Grinder

MANUFACTURED in 1, 1½ and 2 hp capacities, Gaston power grinders are offered for such purposes as weld grinding, cleaning rusty or scaly steel or smoothing flame-cut edges. These grinders operate at 3,400 rpm from any three-phase, 60-cycle, 230-volt power source. A separate overload cut-off for each grinder is recommended as auxiliary equipment. GASTON POWER TOOLS, 2657 W. 95th St., Evergreen Park, Ill.

* *

Morton high duty draw-cut flash trimmer for removing upset metal

Flash Trimmer

A NEW specially made cutting machine, is available in sizes ranging from 12 to 28 in. of trimming capacity and ¼ in. metal thickness, is arranged for removing the upset metal (flash) from flash or butt welds made by the resistance-welding process. It has a lower horn for circular (or rectangular) work that will accommodate a minimum diameter of 9 in. Each of the upper and lower rams has three or more tool holders, and adjustable-bit cutters are used with a fine-patch screw for cutter adjustment. MORTON MFG. CO., Broadway and Hoyt, Muskegon Heights, Mich.

* *

Dust Mask

PROTECTION against nuisance or harmful dust is afforded by the new "Fulface" mask, a lightweight, flexible respirator that fits all facial contours. Its twin filters may be removed from their aluminum containers and thrown away when they are no longer serviceable. Rubber air deflectors direct incoming air over the inside surface of the lens preventing it from fogging. MINE SAFETY APPLIANCES CO., Braddock, Thomas and Meade Streets, Pittsburgh 8.

NOW! A NEW A-C WELDER THAT WILL GIVE YOU EXCELLENT RESULTS

AT LAST a new A-C WELDER that will give you excellent results

1. ON ALL METALS
ferrous and non-ferrous

2. ON ALL GAUGES
heavy or light

3. IN ALL POSITIONS
overhead—vertical—horizontal

To users and distributors of welding equipment we proudly announce a NEW ARC WELDER. We believe it to be superior in performance to every other arc welder obtainable today

The radically different patented design of the KERN WELDER makes possible a better welder at a better price.

KERN

Units for large industrial plants and small repair shops. Three Industrial models 200, 300 and 400 amps. 220–440 volts 60 cycles Two Farm models—130 and 180 amps. 230 volts 60 cycles

Does your present Welder—AC or DC—have all these advantages? . . . THE NEW KERN DOES!

1. Low initial cost.
2. Low operating cost.
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4. Instant starting arc—smooth and stable at any amperage.
5. "Stepless" current selection with turn of control wheel.
6. Cool in operation (NEMA specifications).
7. Maximum portability and light weight.
8. Convenient helmet, cable, and accessories storage.

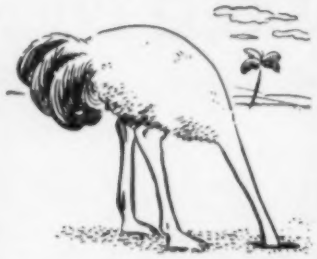
If your welding requirements demand a welder that can do the job *better* for a *larger* time, we know it will pay you to investigate the KERN. For complete information—write us today.

DISTRIBUTORS

If you are interested in selling what we sincerely believe to be the most versatile and BEST line of Arc Welders on the market today, we would like to hear from you right away.

JOHN A. KERN CO. 224 N. LOOMIS ST. CHICAGO 7, ILLINOIS

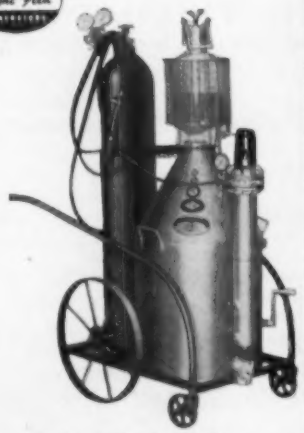
Out of sight ...out of mind!



• Don't let your acetylene be "Out of sight—out of mind!" Users of "bottled" acetylene know that they often run out in the middle of a weld or cut—because the gauge shows only the available pressure and not the amount of acetylene that remains in the cylinder.

You see as you save with Sight Feed Acetylene Generators—because the carbide is always visible through the transparent Pyrex hopper.

Don't let your acetylene be "Out of sight—out of mind"—use Sight Feed. Get full details from your distributor or write for catalogue 44-G.



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THE SIGHT FEED GENERATOR CO.
RICHMOND, INDIANA

About People

J. A. THOMAS has retired as president of the Liquid Carbonic Pacific Corp., Ltd., subsidiary of Liquid Carbonic Corp. P. F. LAVEDAN, president of the parent company, has assumed this position, while H. C. MATHEY has been named general manager of the company. DR. REGINALD M. JONES has been appointed head of the newly organized research division of Liquid Carbonic Corp. This division entails a control, research and industrial laboratory under the supervision of EVERETT W. ELLISON, RALPH ROSE and ROBERT MATTHEI, respectively. LEE W. KINNEY has been appointed distribution manager for the company succeeding FRANK B. ANDREWS, now production manager of the bottlers' machinery division.

* *

LOUIS K. BIRINYI, welding engineer, has been appointed to the staff of Battelle Institute, Columbus, O., where he will be engaged in research on welding materials and processes. Mr. Birinyi is a graduate of Ohio State University and a member of the American Welding Society.

* *

RAYMOND L. COLLIER has been appointed executive vice-president of Gray Iron Founders' Society, Inc. His headquarters will be in the Public Square Building, Cleveland.

* *

AL SEEDORFF has been appointed exclusive representative of Progressive Welder Co. for the state of California. Mr Seedorff's headquarters is located at 10990 Wilshire Blvd., Los Angeles 24.

* *

ALFRED G. FINLAY has been appointed manager, stainless steel division, U.S. Steel Supply Co., Chicago.

* *

ARTHUR MCCUTCHAN has been appointed senior research engineer, product engineering and research department, Tube Turns, Inc.

* *

HOMER PARSON has been appointed director of exports for American Brake Shoe Co., New York City.

* *

LEICESTER B. BISHOP has been named Ohio regional sales manager for All-State Welding Alloys Company.

* *

E. LABADIE has been appointed service manager of Progressive Welder Co., Detroit.

* *

CHESTER F. SMITH has been named a vice-president of the Standard Oil Co., New Jersey.

THE ELGIN
AC ARC WELDER

Does MORE work at LOWER cost

New design improvements and operating features make the ELGIN your answer to *low operating costs, maintenance savings.* Easy to start and to operate. Cool in operation. 4 models . . . 150, 200, 250, and 350 amps.

John Ruskin said:
"There is hardly anything in this world that some man cannot make a little worse and sell a little cheaper and the people who consider price only are this man's lawful prey."

INVESTIGATE ELGIN!

Write today for Details!

LEFT
The ELGIN Model "G" Pneumatic Hammer
Lightweight, compact, sturdy. Locks tools into chuck. Minimum vibration.

RIGHT
The ELGIN Electric Brazing Torch
Connects to welder for brazing, preheating, many other uses. Economical to operate—substantially constructed.

• Distributors inquiries invited.

BORM
MANUFACTURING COMPANY
Elgin, Ill. U.S.A.

Recent appointments in the compound and plastics division of the G-E chemical department are: H. ARTHUR HOWE, superintendent, CLARENCE H. SLAYTON JR., engineering manager and J. RAE STIRRAT sales manager, all of the compound division; NATHAN A. FREUDEN, plastics division sales manager.

* *

STUART HAAGENSEN has been appointed manager of the employment department of the Allis-Chalmers Mfg. Co. MICHAEL F. BLANCARD has been named manager of the company's health and safety department.

* *

CARL A. EVERSMAN has been promoted plant superintendent of American Stove Company's Lorain, O. division. Mr. Eversman will retain his present position of industrial manager along with his new responsibilities.

* *

M. MULLIGAN and T. COLLINS have joined the sales staff of J. A. Cunningham Equipment, Inc., Philadelphia. Mr. Mulligan will handle the Philadelphia-Reading area and Mr. Collins, the Wilkes-Barre vicinity.

* *

WALTER GIGER, formerly chief engineer in the railway locomotive division of Brown-Boveri & Co., Baden, Switzerland, has rejoined Allis-Chalmers Mfg. Co., Milwaukee. Mr. Giger is in charge of promoting the firm's interest in the transportation industry.

* *

H. J. FRASER and H. J. FRENCH have been elected vice-presidents of the International Nickel Co., Inc. Both men are vice-presidents of the International Nickel Co. of Canada, Ltd.

* *

ROBERT W. FERRELL has been appointed manager of employee and community relations of the affiliated manufacturing companies department, General Electric Co.

* *

C. B. STAINBACK has been appointed industrial syndicate manager of Westinghouse Electric Corp., Pittsburgh. JOHN E. PAYNE has been named headquarters industrial sales manager.

* *

WILLIAM D. TAYLOR has been appointed assistant metallurgical engineer for Lukens Steel Co., Coatesville, Pa. SAMUEL D. LEMMON succeeds Mr. Taylor as engineer of tests.

* *

D. R. BERG has been appointed manager of the heating and combustion section of the machinery division of the Dravo Corp., Pittsburgh.

Now! FASTER! EASIER!

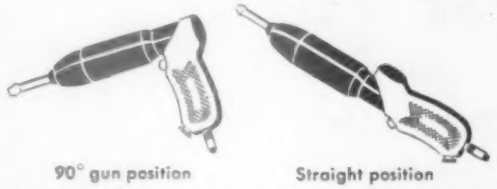
Peening - Cleaning - Scaling

with the NEW
HEAVY-DUTY two-position

salsbury
AIRGUN

(The only air tool with stroke control)

ONE head, TWO positions! In seconds, head is adjustable in either of two positions to suit work.



90° gun position — Straight position

VERSATILE! Removes slag—valuable on multiple-pass work. Removes rust, paint, scale, etc. It's unequaled for peening!

In gun position—peening weld. — In straight position—removing scale.

In any welding operation, the new heavy-duty Salsbury Airgun speeds production—steps up quality—lowers costs.

SAVES TIME! Remarkable two-position head is quickly shifted. Ideal for getting into tight or overhead positions. In seconds, tip is changed to suit type of work.

HIGH OPERATING EFFICIENCY! Handy pistol grip, low weight (4 lbs.) reduce operator fatigue. Controllable striking force assures work uniformity. Operates on 75 to 125 lbs. air pressure, delivering about 5000 strokes per minute. Consumes 5 cf per minute (20 cf compressor is ample).

LIGHT-DUTY MODEL is available for lighter or smaller work. Weighs only 27 ounces—extremely popular on production line operations. No complicated parts! Repays cost in short time and gives years of reliable service. Ask for the Salsbury Airgun at your favorite supplier, or write Dept. 3, The Salscor Company.

THE salsbury AIRGUN

THE SALSCOR COMPANY

1161 East Florence Avenue • Los Angeles 1, California

Without a Dependable MIXER You Haven't Got a GOOD TORCH!

When a torch has a mixer that will function with dependable efficiency, using tip sizes 00 to 12 inclusive . . . compensating for both welding gas pressures and welding tip sizes—and one that will produce a *longer, hotter* flame, using the same gas pressures, you may be sure that *that* torch is trade-marked MECO.

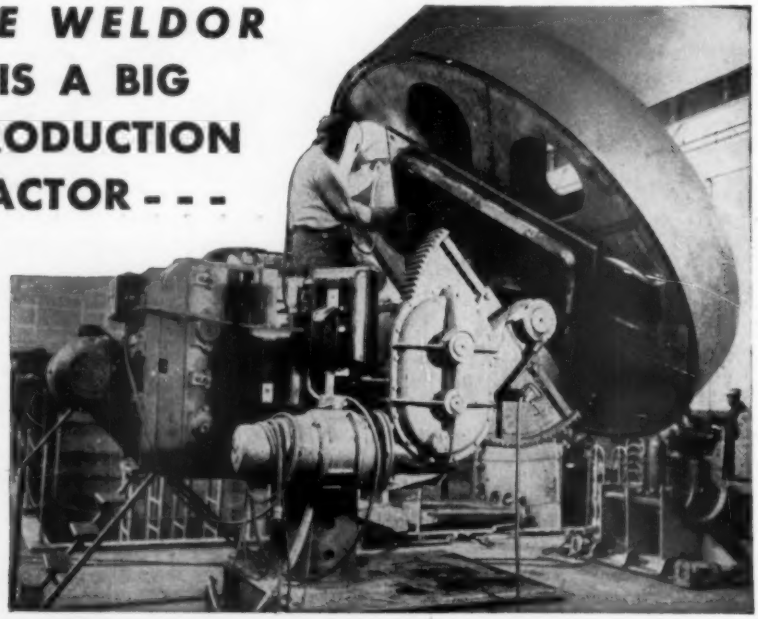
Make your own comparison to prove our claims—a demonstration is all you will need.

What Equipment are YOU using Now? Meco Write us for the Address of Your Nearest Distributor

MODERN ENGINEERING COMPANY, INC.

3411 WEST PINE BLVD. • ST. LOUIS 3, MISSOURI

THE WELDOR IS A BIG PRODUCTION FACTOR - - -



Your welders are big production factors when they work with C-F Welding Positioners because these power operated Positioners with variable speed table rotation are real production tools. Better automatic welding is possible because the C-F Variable Speed feature governs table rotation speed from 0 r.p.m. and up—assuring better control of fillet in circular or peripheral automatic welding.

If increased production, better downhand welding and lower costs in your welding department can help you meet the competition for new markets, C-F hand and/or power operated welding positioners should be your first choice. Write for Bulletin WP 22.

CULLEN-FRIESTEDT CO.

1309 S. KILBOURN AVENUE CHICAGO 23, ILL.

DR. LEO I. DANA, research manager for Linde Air Products Co., N.Y., has been awarded the 1947 Jacob F. Schoellkopf Medal by the western New York section of the American Chemical Society for scientific work while a member of the section, particularly in the solution of a major oxygen and nitrogen problem in the chemical industry.

* *

RALPH D. HOLCOMB has been appointed sales manager for Harnischfeger Corp., Milwaukee. Mr. Holcomb will direct the sales of all Harnischfeger products, excavators, road machinery, hoists, cranes and welding equipment.

* *

G. D. ANDREWS, formerly vice-president and general manager of Fabricated Buildings, Inc., Springfield, Mo., has been appointed advertising and sales promotion manager of Dearborn Motors Corp.

* *

ROBERT A. NISBET has been named superintendent of the Waterford, N.Y. works of the G-E chemical department. The Waterford Works, which is now under construction, will be used for the manufacture of silicone products.

* *

WINFIELD RICE has been appointed plant superintendent of the California Air Products Co., Huntington Park, Calif., subsidiary of Burdett Oxygen Co.

* *

R. C. SOGGE and LEE F. ADAMS have been appointed manager and consultant, respectively, of General Electric's standards divisions.

* *

RITNER W. TOMLINSON has been appointed superintendent of the Easton, Pa. plant of the Pennsylvania Salt Mfg. Co.

* *

WILLIAM C. BEDDOE has been appointed advertising and sales promotion manager of Divine Brothers Co., Utica, N.Y.

* *

J. G. BOLLINGER has been appointed San Francisco district sales manager of Air Reduction Sales Co.

* *

LYALL B. WHITE, formerly with National Cylinder Gas Co., has joined Steele Gases, Inc., 127 N. Dearborn, Chicago, as sales and service engineer.

Died

CARLOS WHITNEY Van LAW, mining engineer with the Vanadium Corp. of America, New York, and vice-president of its subsidiary, Rhodesian Vanadium Corp., died at his home, Pelham, N.Y., after a brief illness.

TWO REVOLUTIONARY NEW PRODUCTS by WOW

Made by WELDORS for BETTER Welding

•

No. 700 ROD

For WELDING
• DIE CAST WHITE METAL
• SHEET and CAST ALUMINUM

•

No. 1 FLUX

For WELDING and BRAZING CAST IRON

THERE is nothing comparable to the No. 700 rod for ease and scope of application. No flux required, no precleaning of the metal, no porosity in the deposit.

No. 1 flux works perfectly with either bronze or cast iron filler rods. Unbeatable for silver brazing stainless steel. No precleaning—does not leave a hard, glossy scale.

Nothing Finer Available

Try them and you'll like them

Distributors: Territories Available

WRITE US TODAY

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WELDING SPECIALTIES CO.
149 S. WESTERN AVE.
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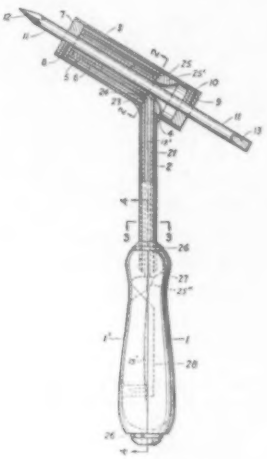
From the Patent Office

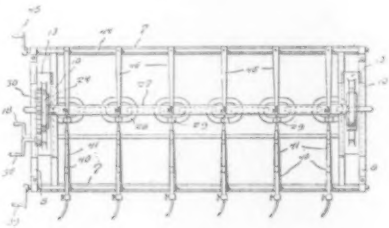


Electric Soldering Iron

2,414,482 KELSO NORMAN, San Francisco, Calif. Filed Oct. 18, 1943. Issued Jan. 21, 1947.

In an electric soldering iron, a heating element comprising a solid ceramic spool with a central passage for the soldering bit. Around this passage is a circular row of holes through which a coil of resistance wire is threaded back and forth from one hole to the other. Both ends of the spool are recessed and filled with a refractory insulating cement covering the ends of the holes and the coils. The connection of terminal wires to the resistance coils is within the holes in which the resistance wire coils are positioned.

★ ★



Chain Welding Apparatus

2,414,970 LIONEL D. MORELLE, Shrewsbury, Mass. Filed April 5, 1944. Issued Jan. 28, 1947.

A chain welding apparatus comprising a means for moving slides transversely of a frame. The chain holder rotatably mounted on the slides and comprises a pair of channel members adapted to receive links of the chain. Sectional rings, to which the channel members are secured, are rotatably carried by the slides, and a means is connected to the holder for rotating them. The frame carries a battery of welding torches and filler rods.

The Welder Farmers Want!
The GREYHOUND

Six Outstanding Sales Features make it profitable to handle GREYHOUND Farm Welders

- Can be used on any farm with suitable power lines. Greyhound Farm Welder meets NEMA standards and conforms to EEI and REA requirements.
- Built-in power factor correction, ideal for rural poser lines.
- Safe-frame and housing of welded steel electrically grounded metal case.
- Continuous current control, quick adjustment by simply turning a hand wheel providing infinite number of current settings.
- Portable—easily moved about.
- Economical to operate.

Dealers! Distributors!

Some territories still open . . . Write today

Greyhound offers a complete line of
HEAVY-DUTY INDUSTRIAL
A.C. ARC WELDERS
Send for catalogs.

GREYHOUND A. C.
ARC WELDER CORP.

Main Office and Plant:
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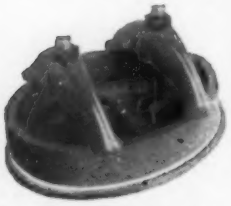
Export Department:
75 West St., New York City.
Cables: "DAVTEXCOE" New York.

LENAPE MANWAYS and FITTINGS

SIMPLE • ECONOMICAL



Ring and fittings assembly for tank construction.

Lenape elliptical access openings (straight rings or flued and curved saddles) and fittings, of the pressure loaded or "self-energized" type are produced in sizes ranging from 4" x 6" to 18" x 24".

Swing support gear, to carry cover inwardly or outwardly of the pressure vessel, as illustrated at the left, is particularly convenient where frequent access is necessary. Various other types are available.

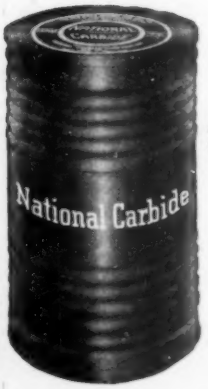
Externally removable manhead support.

Write today for our Bulletin 4-61 and current price schedule S-47 — feel free to call upon our engineering department to discuss design and fabrication problems with you.

LENAPE HYDRAULIC PRESSING & FORGING CO.
P.O. BOX 104 WEST CHESTER, PA.
RED MAN PRODUCTS

National
Carbide

EFFICIENT
ECONOMICAL
DEPENDABLE
for
Welding and Cutting
SPECIFY



NATIONAL CARBIDE IN THE RED DRUM

Write us for information as to nearest available stock.

NATIONAL CARBIDE CORPORATION

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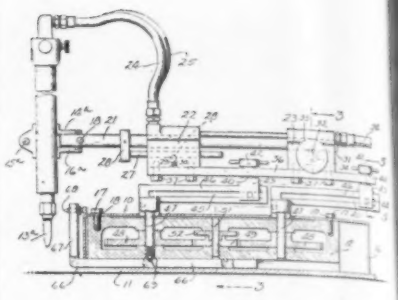


Oxy-acetylene Cutting Machine

2,414,750 FRED B. LOUCKS, JR., Milwaukee, Wis. Filed May 6, 1944. Issued Jan. 21, 1947.

A flame-cutting machine including a frame, a shaft adapted for manual rotation, a worm mounted adjacent of the inner end of the shaft, a worm gear connecting with the worm, a pinion gear fixed to turn identically with the worm gear, a pair of oppositely mounted gears meshed with the pinion gear and mounted on turnable vertical shafts in the frame. A pair of horizontal arms are fixed to the upper ends of the vertical shafts; these have longitudinal laterally opening slots through which a pair of travelers are engaged. The travelers carry a bar on which a pair of horizontal sleeve members are fixed. The torch holder is on a rod movable longitudinally relatively to the bar.

★ ★

Acetylene Generator

2,415,328 ARTHUR H. ANDERSEN, MILTON EATON and ANDREW C. HOLM, Shawinigan Falls, Quebec, Canada, assigned to SHAWINIGAN CHEMICALS, LTD., Montreal, Quebec. Filed April 14, 1945, in Canada Dec. 30, 1944. Issued Feb. 4, 1947.

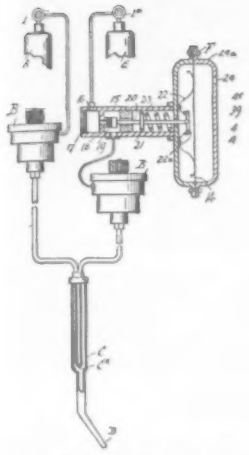
In a generator for the production of acetylene and lime hydrate, the steps of feeding calcium carbide into a closed generating zone from a terminal portion of a feed zone which is cut off from the main source of carbide while replacing from an intermediate portion of said feed zone the carbide fed from the terminal portion. When carbide is loaded into the initial portion of the feed zone, communication between the intermediate and terminal portions is shut off. The intermediate portion is brought into communication with the initial portion, replenishing it with carbide, then the intermediate portion is isolated from the initial portion. Carbide removed from each portion of the zone is replaced with an inert gas which is vented from the portion as the carbide enters.

★ ★

Soldering Iron

2,415,542 MIKE VAWRYK, Lyndora, Pa. Filed Feb. 7, 1942. Issued Feb. 11, 1947.

A soldering head having a tip, a solder reservoir and a heating means within the head. A solder conduit leads from said reservoir through said tip, and a valve regulates the flow of solder through the conduit.



Gas Welding Equipment

2,414,345 HENRY ALFRED ERNEST TALLEY, London, England, assigned to MEDICAL & INDUSTRIAL EQUIPMENT LTD., London, England. Filed Nov. 27, 1943, in Great Britain Mar. 4, 1943. Issued Jan. 14, 1947.

Oxy-acetylene cutting and welding apparatus comprising a welding tube including a jet and a tube surrounding the jet. The latter has a restricted area adapted to cooperate with the jet to produce subatmospheric pressure. There is also a sensitive demand regulator, including a diaphragm having one of its faces subjected to atmospheric pressure and positively actuated by the same when its other face is subjected to subatmospheric pressure. A valve in the acetylene gas passage is controlled by the diaphragm to open when the diaphragm is subjected to subatmospheric pressure. The demand regulator is also provided with an outlet, to which a fine adjustment control is connected.

★ ★

Welding Current Control

2,415,532 LAWRENCE J. PULS, Custar, O. Filed Sept. 16, 1943. Issued Feb. 11, 1947.

A welding electrode providing a stabilized control for a relatively remote d-c generator having field poles and a rotor. The control comprises an additional field pole intermediate a pair of the field poles of the generator. A load circuit coil for the additional pole provides control means effective to shift the additional pole toward the rotor of the generator against the action of a spring, responsive to manipulation of the operator-handled welding electrode.

★ ★

Soldering Iron

2,415,476 PHYLLIS L. ESLER, Detroit. Filed Jan. 22, 1945. Issued Feb. 11, 1947.

A soldering iron of hollow construction having a head on the front and a handle attached at the rear end. A tube positioned longitudinally in the iron has its front end communicating with an opening in the head and its mean end extending through the handle; this tube is adapted to contain a stick of solder. An electric heating coil in the head surrounds the front end of the tube.

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SOFTLY controls the vicious "jolt" of high pressure oxygen gas, thus eliminating regulator repairs and preventing possible injury to operators.

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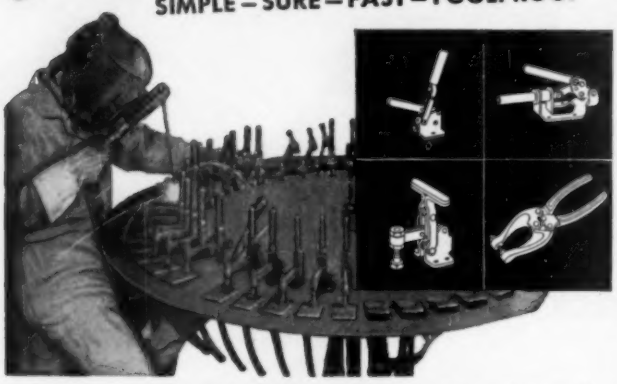

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Industrial Goods Co., 403 W. Douglas, Wichita
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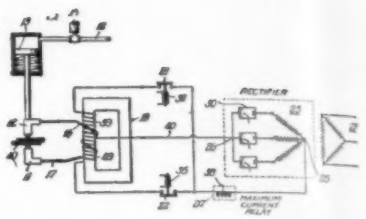
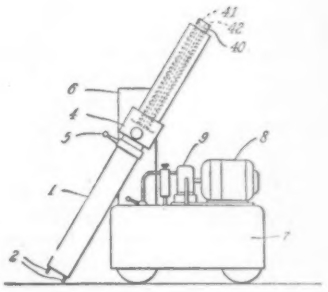


Stored-Energy Welding

2,415,708 DAVID SCIAKY, Chicago, assigned to WELDING RESEARCH, INC., Chicago. Filed June 23, 1944. Issued Feb. 11, 1947.

A method of electric welding whereby a balanced load is drawn from a multiphase alternating current supply. The steps are: rectifying the alternating current to direct current, applying impulses of direct current in continuing succession to the primary winding of a welding transformer, controlling the magnitude and duration of each d-c impulse, reversing the direction of current flow through the primary winding on each impulse to induce an alternating current in the secondary circuit of the welding transformer. The latter alternating current flows through the workpiece to weld it.

★ ★



Automatic Welding Head

2,415,052 ERIC SUGDEN WADDINGTON, London, England, assigned to THE HARTFORD NATIONAL BANK AND TRUST CO., Hartford, Conn. Filed July 14, 1944, in Great Britain April 16, 1943. Issued Jan. 28, 1947.

A welding head, comprising a frame member mounted within a supporting member and rotatable about its longitudinal axis. A number of electrode holders are mounted in the frame member for supporting electrodes substantially parallel to the axis of the frame member. The holders are movable parallel to and in the direction of the longitudinal axis of the frame member.

★ ★

Electrode Coating

2,415,149 PER YNGVE SJOMAN, Gothenburg, Sweden, assigned to ELEKTRISKA SVETSNINGSAKTIEBOLAGET, Gothenburg. Filed Feb. 14, 1945, in Sweden Feb. 29, 1944. Issued Feb. 4, 1947.

A flux coating for an arc-welding electrode having the following analysis: SiO_2 23-50%, Al_2O_3 0 to 5%, FeO from metallic iron 2–11%, FeO from iron compounds 14–25%, CO_2 from carbonate 8–17%, MnO from metallic manganese 22–49%, and Na_2O 1–4%.

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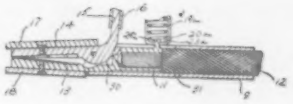

Electrode Holder

2,415,671 CHARLES CAMILLERI, Detroit, assigned to BORDON MFG. CO., INC., Detroit. Filed Dec. 1, 1944. Issued Feb. 11, 1947.

An electrode holder comprising a cup-shaped cable connector, a clamping jaw, an auxiliary jaw in pivotal relation to the first jaw, a handle connected to the auxiliary jaw and overlying said cable connector, a spring positioned between the handle and cable connector for normally urging the jaws into clamping relation, means on the hollow portion of cable connector for determining the location of the lower end of the spring and retaining it in location and an insulating covering for the lower end of the spring. The insulation terminates at a point rearwardly of the rear end of the cable connector.

* *

Electrode Polisher

2,414,834 CHALMERS H. RANDOLPH, St. Paul, Minn., assigned to MINNESOTA MINING & MFG. CO., St. Paul. Filed April 7, 1944. Issued January 28, 1947.

A spot-welding electrode polisher comprising an anvil member adapted to be inserted between two welding tips. Guide members are positioned adjacent the sides of the tips when the latter are in abrading position, and a guide threads and holds a length of abrasive tape between the face of a tip and the anvil. The means for holding the roll of abrasive tape comprises a cylindrical collar having a side opening through which tape may be led within the collar toward the anvil. The means for retaining the roll in the collar comprises pivotally mounted arms extending across the open ends of the collar and held in roll-retaining position by a spring.

* *

Pressure-Welding Method

2,415,912 EGON B. SCHERL, Niagara Falls, N. Y., assigned to THE LINDE AIR PRODUCTS CO., New York. Filed October 29, 1943. Issued February 18, 1947.

Process and apparatus for welding hollow members by first placing them in abuting relation under a selected pressure. An aligning member of combustible material extending within the passage in the abutting portions of the two members, which are heated at and adjacent the abutting surfaces to a temperature substantially below the liquid temperature of the metal. Upset metal is thus forced inwardly within the members at and adjacent the interface formed by the abutting ends. A selected volume of a metal-combusting gas is flowed into contact with the upset metal and aligning member while they are at their kindling temperatures, thereby consuming them. The flow of gas is discontinued when a selected portion of the upset metal has been consumed.

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Contracts Awarded

★ **Calif., Napa**—WATER PIPE—City, City Hall, welded sheet steel water pipe accessories, appurtenances Conn. Creek Proj. pipeline, Schedules A and D, to Basalt Rock Co., Inc., 900 8 St. $831,719. Bids 3/11, awarded 3/14.

Low Bidder

Calif., Sacramento—PIPELINE—State Div. Water Resources, P. Wks. Bldg., Sacramento, Mar. 19, pipeline from Rector Creek Reservoir to Veteran's Home, from N. P. Van Valkenburg & Co., Howe, Ave., North Sacramento, Plan 1, $111,445; and Plan 2, $119,854.

Low Bidder

Calif., San Diego—STEEL PIPE, etc.—City, Civic Center Bldg., Mar. 11, 2nd unit San Vincente Reservoir to Lakeside, rein.-con. pipe, and Schedule 2 from American Pipe & Constr. Co., 4635 Firestone Blvd., South Ga te, $403,085 and $289,440 respectively; steel pipe, from L. E. Dixon Co., San Gabriel, $462,674.

Contracts Awarded

★ **Conn., New Haven**—GAS HOLDER—New Haven Gas Light Co., 70 Crown St., 5,000,000 cu. ft. capacity gas holder, to United Engineers & Constructors, Inc., 1401 Arch St., Phila., Pa. Over $500,000. Awarded 3/8.

Contracts Awarded

Fla., Miami—Dade Co., A. D. Barnes, 1302 Courthouse, Miami, storage tank and pump station, to Nu-Way Enterprises, 2196 N. W. 7 Ave., $32,300. Bids 3/18.

Low Bidder

Fla., St. Augustine—STEAM DISTRIBUTION SYSTEM—State Bd. Control, Tallahassee, Mar. 22, steam distr. sys., at Florida School for Deaf and Blind, from Henry G. Dupree Co., 1102 Alvarez St., Jacksonville, $167,633.

Low Bidder

Ill., Joliet—TANK —State Div Architecture & Engineering, Armory Bldg., Springfield, Mar. 18, elevated tank, Proposal A1 from Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago, $57,682.

Low Bidder

La., Armandville—GAS TRANSMISSION, etc.—Town Council, Mar. 4, natural gas transmission and distr. sys., from J. W. Carruth Pipe Line Corp., 904 Louisiana National Bank Bldg., Baton Rouge. $126,000.

Contract Awarded

★ **Md., Baltimore**—WATER TUNNEL—Bd. Awards, City Registers Office, City Hall, pressure water tunnel, Liberty Heights-Montebello, to Rosoff Eng. Co., Inc., 292 Madison Ave., New York, 17, N. Y. $9,187,000.

Contract Awarded

Oklahoma—PIPELINE—Texas Pipe Line Co., Philtower Bldg., Tulsa, 16 mi. 6 in. crude oil pipeline between Maysville, and Apache-Seminole crude oil main line. Owner builds. $165,000.

Contract Awarded

Okla., Norman—STEAM TUNNELS, etc.—Bd. Affairs, Capital, Oklahoma City, steam tunnels and lines and appurtenances at University of Oklahoma, to Osage, Const. Co., 1413 S. Blackwelder St., Oklahoma City. $67,930. Est. $70,000. W. H. Schumacher & Co., Petroleum Bldg., Oklahoma City, archts.

Contract Awarded

Tenn., Chattanooga—GAS TANKS—Chattanooga Gas Co., 811 Broad St., 4 propane gas tanks, own forces. $40,000.

Contract Awarded

Texas—GAS PIPELINE—Humble Oil & Refining Co., Humble Bldg., Houston, and Quintana Gas Co., Sterling Bldg., Houston, 10 mi. 8 in. welded joint natural gas pipeline between plant and Tennessee Gas and Transmission Co., main line. Refugio area, own forces. Approx. $110,000.

Contract Awarded

Tex., Bellville—STORAGE TANK—City, 100,000 gal. underground water storage tank, pump, station, to Walter Wilke, Bellville. Approx. $33,500. W. Schneider, City Hall, engr.

Low Bidder

Wash., Tonasket—TREATMENT PLANT—City, City Hall, Mar. 11, 19,600 ft. 6-to-10-in. vitr. clay sewers and treatment plant, from E. McKellar, Cashmere, $109,266. Est. $90,000.

Contract Awarded

Wash., Pullman—STORAGE TANK, etc.—Washington State College, Pullman, distr. sys. and reservoir, to Rushlight Automatic Sprinkler Co., 55 N.E., Farragut St., Portland, Ore., $176,301; steel tank and 100,000 gal. steel water storage tank, to Chicago Bridge & Iron Wks., 22 Battery St., San Francisco, Calif., $24,653 and $27,585 respectively. Grand total $228,539. Bids 3/10 and 3/11.

Structural Bridges and Others

Contract Awarded

Arkansas—BRIDGES—State Hy. Dpt., Little Rock, bridges in Pike and White Counties, to Massman Constr. Co., 737 N. Y. Life Bldg., Kansas City, Mo. $375,333 and $136,900, respectively. Bids 3/28.

Low Bidder

California—BRIDGE—State Div. Hys., Sacramento, Mar. 26, steel plate girder swing bridge, Contra Costa Co., from Charles C. MacClosky, 112 Market St., San Francisco. $217,621.

Contract Awarded

★ **Calif., Hollywood**—BROADCASTING STUDIO—Don Lee Broadcasting System, 5515 Melrose St., Los Angeles, 1 and part 3 story, rein.-con., steel frame broadcasting studio, Vine St. near Fountain St., to Wm. Simpson Constr. Co., 816 W. St., Los Angeles. $2,500,000. C. Beelman, archt., and H. Spackler, assoc. archt., 1019 Union Bank Bldg., Los Angeles.

Low Bidder

Florida—BRIDGE—State Rd. Dpt., Tallahassee, bridge in Escambia Co., from Hardwaay Contr. Co., Bount Bldg., Pensacola. $618,405.

Rejected Bid

Illinois—BRIDGE—State Div. Hys., Springfield, rejected bids Feb. 7, bridge, FAS Route 577, Sect. 9X-1B, Cass Co. LB. $59,169. Low bidder reported W. E. April, p. 158.

Rejected Bid

Illinois—BRIDGES—State Div. Hys. Springfield, rejected bids Feb. 28, bridges in Fayette Co., L. B. $68,378*** Marshall Co., L. B. $161,178*** Cumberland Co., L. B. $139,974*** Fayette Co., L. B. $177,636. Low Bidder reported W. E., April, p. 155.

Contract Awarded

Ill., Wood River—BRIDGE—Illinois Terminal Railroad Co., 710 N. 12 Blvd., St. Louis, Mo., substructure railroad bridge, near here, to Gould Constr. Co., 517 S. Birchwood St., Davenport, Ia.; structural steel, to American Bridge Co., 208 S. LaSalle St., Chicago.

Rejected Bid

Iowa—BRIDGE—State Hy. Comn., Ames; rejected bids Feb. 18, bridge S-757 (1), Scott Co., L.B. $50,354. Low Bidder reported W.E., April, p. 155.

Contract Awarded

Michigan—BRIDGE—State Hy. Dpt., Lansing, bridge in Berrien Co., to W. J. Meacher & Son., Bay City. $747,497. Bids 1/9.

Contract Awarded

Missouri—BRIDGES—State Hy. Comn., Jefferson City, 2 bridges in St. Louis Co., to L. E. Latta Constr. Co., Grantwood, St. Louis. $158,980. Bids 2/28.

Low Bidder

Oregon—BRIDGES—State Hy. Comn., Salem, Mar. 24, bridges, Multnomah Co., from Guy F. Atkinson Co., Porter Bldg., Portland. $317,400.

Low Bidder

★ **New York**—BRIDGES—Bureau Contrs. & Accounts, The Governor Alfred E. Smith State Office Bldg., Albany, Mar. 19, bridges, 6.94 mi. Columbia and Rensselaer Counties, from The Lane Constr. Corp., 37 Colony St., Meriden, Conn., $1,206,299.

Low Bidder

★ **N. Y., New York**—PLATFORM EXTENSIONS—Bd. Transportation, 250 Hudson St., Zone 13, Mar. 21, platform exten. to stations of Lexington Avenue-Fourth Avenue Line, New York City Transit Sys., IRT Div., Manhattan (Group VII), from National Structures Corp., 10 E. 40 St., Zone 17. $1,858,953.

Rejected Bid

★ **N. Y., New York**—BRIDGE—Dpt. P. Wks., Municipal Bldg., Zone 7, rejected bids Feb. 21, highway bridge over Westchester Creek. L.B. Contr., 1 $1,644,000; L.B. Contr. 2 $708,987. $1,800,000. Low Bidder reported April W.E., p. 156.

Contract Awarded

★ **Okla., Jenks**—BRIDGE—Tulsa Co., Tulsa, 24 ft. span steel, concrete bridge across the Arkansas River, to Standard Paving Co., 2119 E. 11 St., Tulsa. $502,231. Est. $500,000. Awarded 3/19.

Low Bidder

Pennsylvania—BRIDGES—State Hy. Dpt., Harrisburg, Mar. 21, bridge, 3,821 ft. Cumberland Co., from James E. Minnich, Wommelsdorf. $165,568.

Low Bidder

Pa., Pittsburgh—BRIDGE—Bd. Comrs. Allegheny Co., County Office Bldg., structural and floor rehabilitation of Coraopolis Bridge 2, Coraopolis, from Kean Wise, Inc., Centennial and Locust Sts., Sewickley, $80,777, est. $80,000; structural rehabilitation of Rankin Bridge, etc. in Rankin, from Carl Jacobsen, 1840 Cecil St., Sharpsburg, Pittsburgh, $114,395, est. $100,000.

Rejected Bid

Texas—BRIDGE—State Hy. Comn., Austin, rejected bids Feb. 19, Sims Bayou bridge, approaches, Harris Co. L. B. $174,314. Low Bidder reported W.E., April, p. 157.

Low Bidder

Texas—BRIDGES—State Hy. Comn., Austin, Mar. 25, bridges, Dallas Co., from Wallace & Bowden, 5513 E. Grand Ave., Dallas, Zone 10, $508,598; Leon Co., from Austin Bridge Co., Box 1590, Dallas, $169,223.

Low Bidder

Texas—BRIDGES—State Hy. Comn., Austin, Mar. 26, bridges, Leon Co., Contrs. 1 and 2, from R. B. Butler, Bryan, $139,455 and $101,087 respectively; Guadalupe Co., from Austin Bridge Co., Box 1590, Dallas, $157,172.

Contract Awarded

Tex., Edinburg—GRANDSTAND—Edinburg School Bd., grandstand, day labor. Approx. $40,000.

Contract Awarded

★ **Tex., Houston**—PARK, etc.—George H. Echols & Assoc., Commerce Bldg., developing Arrowhead Park on Old Spanish Trail Rd. into horse racing track, sports park, stadium and grandstand, etc., force account. $1,100,000.

Contract Awarded

Tex., Houston—STADIUM, etc.—City, M. H. Westerman, secy., stadium and recreation proj., to Fisher Constr. Co., 4711 Greeley St. $99,807. MacKie & Kamrath, 2017 W. Gray St., engrs.

Contract Awarded

Tex., San Antonio—BASEBALL PARK—St. Louis Browns, 3619 Dodier St., St. Louis, Mo., steel, concrete, heavy timber grandstand and bleachers, ground development, and lighting. Purchase and Hire. $97,500.

Contract Awarded

W. Va., Wheeling—BRIDGE—City, 200 ft. span steel girder bridge, for 4 lane approaches over Wheeling Creek Washington Ave., to H. L. Seabright Co., 43 and McCulloch Sts. Est. $100,000.

Low Bidder

Wisconsin—BRIDGE—State Hy. Comn., Madison, Mar. 25, bridges, Sauk Co., and 0.036 mi. Dunn Co., from Brennan Bros., Lansing, Ia., $157,935 and $48,010 respectively *** 0.093